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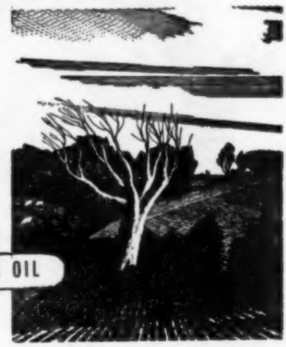

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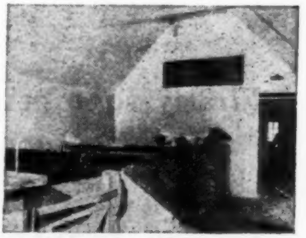

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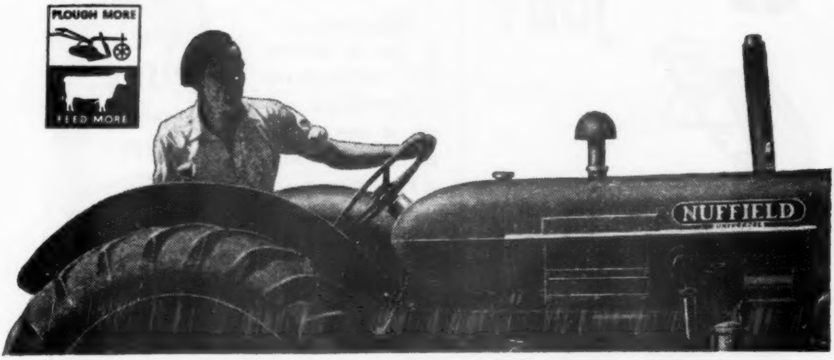

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““# AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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Cover Photograph

By-product into milk. Sugar beet tops fed fresh on a Lincolnshire farm.

AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LIX No. 8 NOVEMBER 1952

RESEARCH FOR PLENTY

No. 1. CHALLENGE TO SCIENCE

PROFESSOR SIR JAMES A. SCOTT WATSON, C.B.E., LL.D.
Chief Scientific and Agricultural Adviser, Ministry of Agriculture and Fisheries

Never in the history of mankind has the problem of feeding the expanding population of the world been so serious as it is today. Can science find the answer? The series of talks broadcast recently by the B.B.C. in the Third Programme was an important contribution to informed opinion on this subject, and it is felt, therefore, that the opportunity will be welcomed of reading them in this JOURNAL over the next few months.

I HAVE often thought how interesting it would be if we could get an independent view of our earthly problems from a group of intelligent observers who happened to be a few jumps ahead of us in science and philosophy. In the last million years they would have recorded advances and recessions of our polar ice-caps, great dryings-up and dampings-down, with consequent effects on the distribution of our forests, grasslands, tundras, and deserts. They would have studied the dependence of the various forms of living organisms upon soil and climate and the one upon the other—plant in relation to soil and climate, herbivore on plant, carnivore on herbivore, parasite on host, and so forth. The first time they recorded the appearance of a man on earth, they must have rated his chance of survival fairly low. He would have appeared to them as an offshoot from a rather unsuccessful group, the anthropoid apes—a slow-breeding species and therefore, from the genetic point of view, very slowly adaptable to change of environment. Poorly protected against cold, physiologically ill-adapted to bear high temperature, he would have been seen as unable to fly and a slow and awkward swimmer. He could not become a seasonal migrant like the swallow or the herring. Again, man's slowness of foot, and his consequent inability to escape the larger predators, or himself to become a successful hunter, would have been only too obvious. Unable to live on grass, the most abundant of all foods, he would have been obliged to subsist on odds and ends—grass seeds, nuts and roots, insect grubs, molluscs, frogs, lizards, honey and so forth. Supplies of such food being rather sparsely distributed, and being sought after by a number of more active species, a very large territory would have been needed to support even the smallest of human groups.

The view would have been inescapable at this stage that, as a participant in the struggle for survival, man was destined to be one of the failures. Several species of ape-men had already petered out and *Homo sapiens*, for

nine-tenths of his existence, has occupied a very obscure place in the world's fauna. Why suddenly did something happen—something very dramatic ? Why were new and cataclysmic changes becoming progressively noticeable in the earth's environment—changes different in kind from those of former ages ? It was because this single species, man, had developed will and memory and the power of speech. He began to make himself potter, smith, farmer, and many things more. Unable to live on grass, he had turned the wild grasses into wheat, rice and maize. In order that he might eat meat and drink milk, he had domesticated the herbivora, and himself, with tools of his own making, had eliminated their predators. To overcome his natural slowness of foot, he had tamed and was riding the wild horse and, finally, within the last two centuries (our own times in fact) he had waged an increasingly successful war against his own parasites and diseases.

Thus far, the story would be one of sheer conquest. Man is seen no longer to fight for survival with the forces of brute nature. The forces seem to revolve round him, under his control. The numbers of his species have risen to some twenty-five thousand millions, and the marks of his cultivation show on the Arctic fringes of Canada and Russia and in deep cuttings into the tropical forests. Yet, to the outside observers, something bewildering seems to be happening now. A state appears to have been reached of complete ecological unbalance of the globe's flora and fauna. A projection of the current net reproduction rate of man implies a doubling and redoubling of his numbers at intervals of about two generations, while his food production is expanding at a slower rate. In fact, it is too slow even to maintain human energy at a level which already, for many individuals, appears inadequate. Well might our outside observers begin now to speculate about the possibilities for ensuring man's survival—the likelihood of wars of extermination, like those previously noticed in primitive man's fights for hunting grounds; or planned control of the reproduction rate to restrict the numbers to be fed, using the same scientific methods as have controlled the rest of nature ; or, again, a concerted effort to achieve a yet higher rate of progress in the processes of food production. It is this last approach that we are to explore in the present talks.

MR. PIRIE, who is speaking in the last of this series, will say that our trouble has largely arisen from the unbalanced application of science ; meaning that, in the past two centuries, the chief outcome of biological research has been the saving of human lives, without any particular thought about the problem of feeding the survivors. PROFESSOR ASHBY, who follows me, will remark that our generation is the first to worry seriously about its great-grandchildren. There is a lot of worrying today. A dozen or more books have been written during these last few years, examining the question of whether, and if so how, our great-grandchildren can be fed.

Let me mention some of the elementary facts, though they are quite generally known. Man, like other animals, needs a source of energy in order that he may work or move or even just keep alive. The necessary energy is produced by respiration—that is, the breakdown, in the body, of nutrients—sugar and starch, fat and protein. The energy is released partly as heat but partly also as chemical energy to support life and permit activity.

In nature these nutrients are built up out of carbon dioxide, derived from the air, and water containing dissolved salts. The processing factory is the green plant, the catalyst is chlorophyll, and the source of energy is the light of the sun. But the efficiency of the green plant, as a converter of energy, is, at best, very low—of the order of 2 or 3 per cent,

Another fact is that some of the substances that are formed by the plant are useless as human nutrients. The wheat plant, for instance, stores less than half its energy in its grain, which we eat, and more than half in its straw. Straw is composed of cellulose, and man's digestive system is not designed to deal with that material. Moreover, a considerable amount of the cellulose is coated with lignin, and this prevents digestion even by the ruminant, which is equipped to make quite good use of cellulose as such—for instance, a cow can derive quite a large amount of energy from eating a cotton shirt or a sheet of blotting paper ! But even the cow can make nothing of sawdust, because wood is heavily impregnated with lignin.

Again, many human beings are not content with vegetable foods ; they want at least a proportion of meat, milk, cheese, butter and eggs. But animals are, in the nature of things, inefficient converters. A good hen or a good cow may yield up, in the form of eggs or milk, about a third of the energy of her food. The ox or the sheep yields, in the form of meat, only some 10 per cent. But we shall hear more about this from DR. NORMAN WRIGHT.

What Does Conventional Farming Offer ?

I am an agriculturist ; so let us now turn to the ways in which research can help to step up production under what we may call conventional systems of agriculture—using the land that is already producing food, the established crops like wheat and rice, potatoes and pasture grass, and the established types of livestock—cattle, sheep and goats, pigs and poultry. There is a constant and growing stream of useful discoveries and inventions. Let me take a single crop—wheat, by way of illustration. A vast amount of work is being devoted to genetic improvement of the plant—to produce types that are increasingly resistant to the common diseases ; that will stand up—literally stand up—to more intensive fertilizer treatment ; will put more of their efforts into grain and less into straw ; and will provide the kind of grain that can yield attractive and nutritious bread.

That is the typical story—of a number of separate contributions to progress, some perhaps very slow and others perhaps small, but adding up, over the years, to a substantial total.

In other cases, developments follow each other at almost bewildering speed. For example, there are a fair number of dairy pastures in Britain that today are yielding twice as abundantly, in terms of bottles of milk per acre, as they did ten years ago. This result has been obtained by sowing better plant material, by the more intensive use of fertilizers, and through a system of rationing the pasturage by means of a movable fence, often electric, in order to ensure that the grass is consumed at the most nutritious stage of growth, while a minimum amount is soiled or trodden.

Sometimes, again, the individual research worker makes a discovery with quite spectacular consequences. For instance, a good many areas of our uplands formerly failed to maintain normal health in the sheep that grazed them. The animals pined and the only traditional recourse was to move the flock to healthy land for frequent spells. Now the trouble can be avoided at the cost of administering, once in a while, a farthing's worth of cobalt.

Turning to the most important of farm animals, the three most serious diseases of dairy cattle are—or rather were—mastitis, contagious abortion and tuberculosis. The first yields well to penicillin treatment; the second can be prevented by vaccination, and the third is in process of elimination by

the application of a diagnostic test and the slaughter of the reactors. But despite an immense amount of patient, laborious and brilliant research, there is still no better measure of control for foot-and-mouth disease than the slaughter of whole herds in which it has appeared.

Progress in food production would be faster if agriculture were organized like other modern industries—if it were conducted in large units under skilled management, with high-powered technical advice and specialized craftsmen, and with efficiency and financial gain as the predominant motives. In the advanced countries there are indeed many farms that approach this description. But at the other extreme there are many millions of small peasant holdings, where food production is only one of several activities, where the farm folk are illiterate, where age-old tradition is still almost the only guide, and where the material objective—often difficult to attain—is merely to provide a bare subsistence for the farm family. Moreover, the material objective is only one of many—for example, there is the maintenance of social prestige, the proper observance of religious rules, and the begetting of numerous children.

It is easy to see that many a farming community is ill-organized for food production. The pasture land is in common, so that it is nobody's business to improve the grazing. The cultivated area is broken up into tiny and widely scattered bits and pieces, with an immense waste of both land and time ; the marketing of produce is so ill-organized that there is little inducement to produce for sale ; and the procurement of goods and services is equally ill-organized. All this is perhaps off our immediate point. But it is important to remember that much remains to be done, after the initial discovery or invention, before much in the way of increased production can be expected.

I am often asked, " Isn't it true that, up and down the world, and even in countries like our own, there is a great deal of land, now more or less waste, that could be turned into farms ? " One specific question that I had recently was " Couldn't we put a dam across the mouth of the Wash, and make another county, just as Holland is creating a new province out of what was the Zuider Zee ? " Well, the answer is that the floor of the Wash is worthless sand. All we can do is to wait for the silt to pile up along the foreshore and make intakes of a few hundred acres at a time. That process has been going on since the time of the Roman occupation.

But could we not do more on our hillsides and our higher valleys ? Something, no doubt. Perhaps squeeze out another two million acres of moderate soil in a rather cold and wet climate, adding perhaps 5 per cent to our farm area, but something substantially less to our productive resources.

Well, what about other countries ? Aren't there deserts that could be irrigated, swamps that could be drained, forests that could be cleared ? There are. And the work should be taken in hand ; but the gain may be largely counterbalanced by items on the other side of the account—by the progress of erosion and the diversion of land to other purposes—mining, water supplies, building of houses and factories and other competing uses. No doubt WALTER RUSSELL, in his talk on the soil, will have more to say about this.

Well, but what about the vast expanse of tropical forest ? A trying climate, of course, especially for white men. But one could provide air-conditioned houses, perhaps even air-conditioned cabs for the tractors. No doubt too, there would be trouble with weeds—the jungle would fight back ; but what about all these new and wonderful weed-killers ? And surely

land that can produce an immense growth of useless vegetation could be made to grow food crops. I have no particular right to an opinion. But there are well-known and great difficulties. The tropical forest soils are old soils—the region has never been refreshed by deposits of boulder clays. They have been subjected for millions of years to the washing of tropical rains, and their stock of plant food is minute. Fertility is maintained, under forest vegetation, by the very rapid circulation of that tiny stock, which is taken up by the plant roots, returned in the heavy leaf-fall, set free by the intense activity of white ants and soil organisms, and immediately taken up again. When the cultivation of annual food crops has been attempted, as it has been in many places, extreme soil impoverishment occurs unless fantastic quantities of fertilizers are applied. But there are possibilities—the oil palm, for instance. Its production per acre of oil, which of course is edible, is far higher than that of butter from our best dairy pastures. The number of tropical trees that are potential food producers is probably small ; but man has made wheat and rice out of wild grasses ; has turned a crab apple into a Cox's Orange ; and he might well explore intensively the possibilities of the tropical tree flora.

Beyond the Conventional But cannot we attempt something altogether more fundamental ; something less tedious than farming as we know it ? The first big revolution in man's economic history was the domestication and cultivation of the most useful plants and animals, instead of seeking for morsels of edible material in wild nature. Cannot modern science find a way of converting useless plant material into food ? The tiny organisms in the cow's rumen produce a ferment that dissolves cellulose. Cannot we imitate the process on a factory scale, and turn straw into human food ?

If we must stick to the green plant as the basic mechanism for making sugar out of air and water, need we stick to the conventional crop plants ? Because there is evidence that tiny green algae, floating in moving water, can carry out the same reaction with a considerably higher degree of efficiency.

Must we use the animal to turn grass into a human food, since, as said, it is a very wasteful converter ? I hope that Mr. Pirie will tell us about his work on the extraction of the protein of grass leaves—of making cheese without cows.

But again, must we continue to rely on the green plant ? It is hardly an answer to say that edible fats can be synthesized from coal, which indeed is true ; but this would only cause yet another drain upon the world's fuel resources, which are far from inexhaustible—unless indeed the raw materials for atomic energy prove to be almost infinitely large. And in that case it might be better, highly expensive as it would be, to synthesize carbohydrate, in a factory, out of the same materials as the plant uses. On paper it is a simple business. $CO_2 + H_2O + CH_2O$ (formaldehyde) $+ O_2$ (oxygen), and six times CH_2O is $C_6H_{12}O_6$, a sugar of sorts. Would the farmer worry about being put out of business by the chemist ? I hardly think so. If the chemist could provide synthetic sugar and bread, the farmer could give up growing wheat, which is rather a dull job, and sugar beet, which is rather a messy crop anyhow. And he could concentrate on bacon and eggs, strawberries and cream, lamb and green peas, chicken and asparagus ; so that everybody could be happy. But all that is only a pleasant dream ; the actual prospect is far from cheerful.

WORLD GRASS

Sir George Stapledon, C.B.E., D.Sc., F.R.S.

Grass occupies one-fifth of the world's land surface. In it there are vast possibilities of increasing the supply of meat and milk which an ever-increasing world population demands.

WORLD statistics tend to be as overwhelming in their implications as they are in their magnitude. We can ignore them, however, only at our peril. Because, of necessity, they can be but approximations, is no excuse for brushing them aside and refusing to face the difficult, nay alarming, issues that clearly face mankind. Man's ultimate destiny, and the unfolding of his full potentialities, are determined in the last resort by his health. Health depends upon a just balance between food, both quantitatively and qualitatively considered, and population. Today it is perhaps generally realized, if only in a casual way, that world population is increasing at an alarming rate and that there must be a limit to the amount of food which it is possible to produce on our planet. We have not yet sufficient scientific evidence to estimate with precision the amount of food of appropriate sorts and qualities which could be produced, but we do know that even to meet present optimum requirements we are not producing enough.

Man stands at the crossways. Some measure of optimism for the future—and the not distant future at that—is justified only if there is a great awakening and if all men of all countries and of all shades of opinion realize to the depth of their beings that the welfare of man on an over-populated and under-food-producing planet turns not upon gadgets and mechanical developments run riot but upon all developments—both industrial and agricultural—being governed by good husbandry. Good husbandry means, briefly, optimum production compatible with the conservation (and not the dissipation) of resources. The Food and Agriculture Organization is still plodding away at that gigantic problem of suggesting the ways and means of feeding the world's population—which the organization has been set, if not to solve, at least to explore and to document. Their recent publication *Improving the World's Grasslands* is of great significance for the very good reason that the grasslands and grazings of the world are not pulling their weight. Grass comprises the predominant acreage of food-worthy land, and it is of equal significance that animal products (milk and meat) mean much to the health and vigour of mankind.

Cropland and Grassland Here are a few figures, which allowing for a very large margin of error, remain highly revealing and not a little frightening. Of the total land area of the world, only about 10 per cent is cropland, and this small proportion produces about 90 per cent (mostly cereals) of the world's food supplies. Pasture and range land cover some 20 per cent, and most of this is stated not to be fit for crop production. Forests cover some 27 per cent, and practically barren lands 43 per cent.

It is not only that cropland contributes most per 1,000 acres to the world's food supplies, but speaking generally, young and fresh grass, such as that provided by tended permanent pastures (in effect man-made) and leys, contribute far more grass nutrients for stock per unit of area than do the natural grazings of range and other lands. More than this, it is now realized that the roots of grasses profoundly influence the care of soil structure. In the detailed study of root development and root influences and the factors

which impinge upon both in relation to soil stability and fertility we are clearly on the threshhold of great advances—advances which are assuredly destined to make their mark on husbandry and food potential in both temperate and tropical regions.

If we are to achieve telling increases in world food production and that better balance between cereal and livestock products which is so important in the interests of sound nutrition (it will never do to regard livestock merely as an insurance against famine in terms of crop failure), it is essential to explore every possible way of increasing the area under cultivation. Rotation is the key to advance, and here we must consider not only the possibilities of rotating tillage crops and grass (as leys), but also leys after leys (often extremely long ones) as well as all methods of controlled grazing and the proper sequences of cutting for hay or silage and grazing. All the factors involved receive detailed consideration, but since the F.A.O. study is dedicated to "improving grassland" the information is presented in a manner only incidental to what I regard as the basal necessity. As knowledge advances and facilities improve (the acceleration of knowledge and facilities at least keep pace with that of population), it seems to me almost certain that it will be possible to replace "natural" vegetation with that which is artificial (whether crops or grass or both) and with greatly enhanced soil-preserving as well as food-producing powers, and to do so on no mean proportion of that vast area which now only produces roughage, small in amount and of low feeding value. The wealth of information set forth in this Study invites one to go beyond the terms of reference to which the author and his numerous collaborators have scrupulously adhered, and to have done so is intended as a compliment and to invite students of world grassland and food production to read the publication critically for themselves. I shall revert to what I deem to be the major issue in the interests of posterity in my closing paragraph.

Improvement of the World's Grasslands The story of the world's natural grazings is a sorry affair ; just how sorry can be judged from the fact that at least four-fifths of the total feed eaten by the livestock of the world is roughage. The roughage is usually of insufficient nutritive value per bellyfull eaten and not enough can be eaten per day to provide the hard-working eaters with an adequate ration, even of starch equivalent. The facts presented are tantalizing all along the line. For example, here in England a 10 per cent increase in crop yields would represent a substantial achievement, yet a 50–100 per cent increase in grass yield could easily be achieved, while in favourable areas here and abroad where the use of fertilizers is feasible, profitable increases in yield of grass nutrients of the order of 200–400 per cent are not uncommon.

The whole question of the feasibility of a wider use of fertilizers and, where necessary, of small quantities of copper " needed especially for reproduction of the plant", zinc " for early vegetative growth", and molybdenum " for nitrogen fixation of the root-nodule bacteria " on grazings the world over is both intriguing and baffling. Perhaps on the vast expanses very long-term rotational methods should ideally be practised. Certain areas would be temporarily abandoned, others would be fenced (extensively at first), fertilized and in some cases reseeded. In short, steps would be taken to improve the vegetation and to control the grazing. The issue is a real one and animal population might well be increased by concentrating on the better of the range and other grazings and abandoning the rest until we are ready to tackle them. Nature, left to her own devices, tends rather to conserve

than to dissipate soil resources. In some cases probably it would be wise to assist nature and wilfully to introduce appropriate anti-erosion types of plants on the abandoned areas. In any event, extremely long-term thinking, research and planning are essential if we are to make a noble endeavour to play fair by current generations and by posterity.

It is impossible in a short general article to do justice to the detailed information given in the F.A.O. study for the improvement of pastures and grazings of all types. I cannot conclude, however, without allusion to a few points which bear on the improvement and management of our own mountain and hill grazings, and without a word on indigenosity. Much of practical value is said as to herding, a matter which will become of growing importance in proportion as cattle come back on our open hills and in proportion as suitable areas are fertilized or reseeded. It is pointed out that without some measure of rotational and deferred grazing in relation to the growing season, and with a view to avoiding hard grazing of the same areas at precisely the same period year after year, the vigour of the most palatable and of the potentially most productive plants is bound to be impaired. This means that by overgrazing the yield of nutritive herbage would be greatly reduced and eventually the valuable plants would be suppressed by others less palatable or less productive. The rapid spread of rushes on many areas that were reseeded on our hills during the war afford a telling object lesson of the need of controlled grazing. The situation of watering places and their distance one from another and in relation to prevailing winds have an intimate bearing on the whole question of control and herding, while a length of fence (not an enclosure) cleverly placed may be of great assistance. One cannot help having an unhappy feeling that herding and shepherding on our hills may become a lost art and at a time when their importance is likely to become greater than ever. Here indeed is a fascinating subject for detailed research and one that would give scope to our modern apparatus-minded scientists for the use of highly refined equipment.

A warning is given not to place too much store by indigenous plants, and innumerable examples are quoted of the value of new introductions into many regions—most albeit in "new" countries. The warning is however sound and should be heeded even in this vegetationally well-endowed country. We must ever be on the look-out for new herbage species, but what in my view is perhaps of greater importance would be to effect an exchange of segregates between the Research Stations of the world concerned with the so-called "better" grasses and legumes—red clover, lucerne, cocksfoot, timothy, ryegrass and the like.

Safe and Fragile Soils

My main reaction to this authoritative study is twofold. In the first place I feel more acutely than ever the heavy responsibility that is placed on those countries that have large acreages in fertile land and under climatic conditions where good husbandry, despite intensive production, is adequate to take proper care of the soil. The results obtained in the Netherlands speak volumes for the high productivity of good grass well managed and generously treated. Our own recent experiences have proved the order of output that can safely be obtained in terms of both animal and crop products—that is to say, in terms of both tillage crops and grass—by farming on a sensible and conserving rotation based alike on the ley and tillage, and over a wide range of soil types. The first essential is everywhere to ensure high farming and good husbandry on the best and safest lands, and this places a heavy moral

onus on those farmers who occupy such lands—men who are usually intelligent and not utterly devoid of capital.

In the second place, and with reference to the poorer and fragile soils under exacting climatic conditions, I feel that our knowledge is now sufficiently advanced to justify embarking upon a bolder, more ambitious and exceedingly long-term line of research. If we are to meet the food needs of the rising flood of population in time, it will be essential to increase appreciably the area under cultivation and to extend greatly the area in young and nutritious grass. It is upon this aspect of the problem, along with that of conservation, that research should now be developed. I, for one, as I have already implied, do not for a moment despair of greatly increasing the world's acreage under rotation for both crops and grass and in the process so strengthening, and not weakening, the delicate balance on which the stability of fragile soils depends. In the meantime it is the duty of all men of understanding and goodwill to do all they can to bring home to their fellow-men the gravity of the food-population issue, and it is the duty of all governments to enforce, as far as they are able, the practices already outlined by those who have made a critical study of soil conservation.

THE "B" FARMER

WHO AND WHAT IS HE? AND WHAT ARE HIS POSSIBILITIES?

E. Shaw Browne

The increase to more than 60 per cent over pre-war in our home-grown food production is a target for every farmer, but in many instances it is perhaps the so-called "B" farmer who can make the greatest contribution. Mr. Shaw Browne, who is the Chairman of the Nottingham A.E.C., here tentatively points to the possibilities.

WHEN we contemplate the urgent need to increase our home-produced food supplies we must, naturally, direct our attention to where the prospect and scope is greatest. In doing so, we shall immediately be struck by the great variation in our farming standards throughout the country and, indeed, counties and parishes.

In the attempt to assess the proportions of good, indifferent and bad farmers, discussion and some difference of opinion has arisen as to the usefulness and even the advisability, of adopting a classification which involves a label as, for instance, A, B and C. The argument against has been mainly the impossibility of ensuring complete uniformity in a system of grading which represents the same standard of farming throughout the country. Those who have found the system useful are not impressed with this objection, believing that no such object is necessary in that they are quite clear in their own minds where a farmer stands when he has been recognized as belonging to A or B or C. In any case, if we limit ourselves to three grades or classes, it is well known that all three include almost limitless gradations.

Assuming that we have adopted such a system, we shall not be surprised, perhaps, to find that the largest proportion of farmers we can class "A", a

rather less number "B", and a quite small proportion in the lowest grade. In Nottinghamshire we find (the figures are not quite up to date) 58 per cent, 39 per cent, and 3 per cent in the three classes respectively. Percentage figures can, of course, be affected by improvement in farming practice and also by raising the standard of the grade. It is conceivable that the two may, more or less, keep in step for a time.

The Potential for Improvement The position revealed by such a survey makes clear enough where the greatest hope of advance lies. Our "A" farmers can be relied upon to do well, though it is not suggested that all are 100 per cent—someone has said that the room for improvement is the biggest room in the world—but we can be assured that they, of all classes, are the most conscious of opportunity of advancement and will be most ready to seek the knowledge that helps towards it.

As for the gentleman in the "C" category, we have seen that his numbers are comparatively few, and progress towards his substantial improvement must necessarily be slow. Probably the greatest harm arising from his existence is the example he provides and the toll he takes of the time and energy of those doing their best in the guidance of effort towards general progress. We cannot, of course, leave him alone and, no doubt, the upper strata of his class can, eventually, be persuaded or made to respond ; the residium, it is feared, must be the subject of disciplinary measures.

From consideration of the foregoing, the conclusion is inescapable that in the middle class of farmer, both from the point of view of his numbers and his potentialities for improvement, lies the direction of our concentrated efforts.

So that these efforts shall be intelligent and hopeful, it is necessary to give a thought to the "B" farmer himself ; who is this "B" farmer and why is he in the "B" category ? His class is, of course, of very varying ability, from closely approaching the class above to touching that below him. A brief description of him might be that he is of a standard that was understandable and tolerable in pre-war days but cannot be accepted as meeting necessities as they now exist.

What is certainly understandable, however, is that conditions prevailing in those days should produce his like, and it will not help us to ignore the fact.

It must be said at once that quite a good proportion of farmers still graded "B" are striving hard towards better things—sometimes under considerable difficulties. It is not unusual to find amongst them men who are avid for advice and whom it is a pleasure to encourage and applaud. They are heartened by their successes and the discovery of possibilities ahead of which they once had no hope.

This cannot be said of all, and for various reasons. In some the lack of effort is largely due to disheartenment—possibly a matter of inadequate capital with all that that entails. In others, absence of all but the most elementary knowledge of what is essential for the best in farming is the brake on progress, and still others where it is just a case of apathy. Knowledge, backed by the right approach, can be imparted where its lack is recognized, and example can work wonders, but with the chronically apathetic, even the most brilliant examples all around him fail to provide a spur.

With all the necessary knowledge and good intention, however, it will be seen that where real success is found it has been achieved only by a stubborn

pertinacity, a dauntless determination to surmount difficulty and disappointment, and dissatisfaction with measures short of the best.

A Hypothetical Instance Having indulged to some extent in generalization, may we look now at a typical farm, say, of 150 to 200 acres, where only mediocrity has been attained? The occupant is in his forties or fifties ; he was born on the place and followed his father. The latter farmed through bad times and he himself well remembers them. He looked on his parent as a good farmer and regards himself as good enough—perhaps, in conditions obtaining twenty years ago, with sufficient reason. He works like a Trojan with a son as industrious as himself, and would regard as fantastic a suggestion that one who was such a worker could ever be considered anything but a good farmer. Of technical training he has had none whatever and, in this particular case, neither has his son.

With the possible exception of his idea of what is his minimum necessary acreage of grass, no great fault can be found with the proportions and rotations of his various crops. Most of these are of moderate standard : occasionally he will get a bumper ; just as often a failure or semi-failure. Not always could he say why. In the case of this man it is ironical that, having worked so hard, success has eluded him.

It is not improbable that he has handicapped himself in the first instance by the adoption of a farming policy not ideally suited to the nature, situation and various attributes of his farm and its environment. Choice of alternatives can be vital, but sufficient for him that he inherited the one he follows.

Too complete reliance on the all-sufficiency of the practical aspects of his job has robbed him of the realization of the need for at least an elementary minimum of scientific knowledge.

The results are reflected in crops that could have been so much better had a fuller understanding of the principles of the use of fertilizers led to a more adequate application and a more appropriate selection. Practically all cereals would have shown handsome response to a top dressing of nitrogen, and the same, in generous measure, would have doubled the production of his mowing grass and pastures. And what a pity that field of sugar beet falls so short simply through lime shortage which could have been revealed by test !

It is almost certain, too, that our friend regards his acreage under grass as the irreducible minimum to keep his stock ; so it is—under the treatment it has, or, rather has not, received. Can we persuade him that the keep he has had from that rather poor, badly herbaged and undergrazed ten-acre old grass field can be more than replaced by his remaining grassland under sound and generous treatment and that it can, therefore, be well spared for the plough ? For, even if poor in plant food and needing lime, these wants can be rectified and the store of humus become a bank on which his crops will draw for years.

And what a world of difference could be made on this sample farm by a little more labour and a little more power—an additional tractor, another man (let us hope there is a cottage or accommodation available in the village) ; what a relief to be rescued from being at the mercy of every vagary of the weather ; what added chance of success, for instance, in our wheat sown in October instead of " mauled in " in December. What a change to have no cultivations rushed, with even all our sugar beet and other roots sown before April is out because the land was properly cleaned in the autumn instead of improperly in May.

We are becoming really interested now and looking for fresh fields to conquer. "Hang it, if I'd had the sense to order my seed potatoes before Christmas, Scotch or Irish would not have been all gone, and it's odds that field could have done another four tons an acre."

And how right he would have been, and, talking of seeds, what about other seeds, grasses and clovers suitable as to variety as well as to quality ?—and the same with regard to cereals.

In such and such directions will be found indications for desirable improvements in cropping policy. Likely enough too, the livestock policy is one of pure opportunism, based on no planned scheme or consideration for the ultimately possible.

An Example from Nottinghamshire Early in the last war I had actual knowledge of a farm in Nottinghamshire, most of it rather poor sand land and of about the same size as our hypothetical example referred to above, About the only advantages the occupant possessed was a gift of intelligence, candour and a realization that he did not "fill the bill", though he greatly wished to do so. He readily confessed that in twenty years farming he had steadily lost money. As a consequence his capital was depleted, his credit was not good, and his confidence in his farm and in himself was vanishing. At this stage he was contacted by a W.A.E.C. district committeeman with a practical and sympathetic turn of mind who had faith in him.

Together, problems and possibilities were threshed out. Little that was right was to be seen and production was negligible. Choice of crop for field was not wise, acidity abounded and manuring was hopelessly inadequate —but above all, timidity of planning and lack of faith in what could be done were the most striking features.

Without mentioning further particulars, after help from the W.A.E.C. had been arranged in the way of finance, machinery and labour and continued and detailed advice readily given and taken, results the very first year, coinciding with a favourable season, were beyond anything that could have been hoped, and more than £1,000 profit was made. Though the same occupant, a very different man farms that farm today.

A final word. Experience of a case like this prompts me to say that, of all callings, it is truest of farming to say that nothing succeeds like success and, having arrived there, a man will have no doubt whatever that he is engaged in a job which is the most satisfying, most challenging, most absorbing and most useful in the world.

New Chairman of the Forestry Commission

The Earl of Radnor has been appointed Chairman of the Forestry Commission in succession to the late Lord Robinson.

Lord Radnor was appointed a Forestry Commissioner in 1942 and has been acting as Deputy Chairman of the Commission since July 1951. He is known for his interest in both agriculture and forestry ; at his home at Longford Castle, near Salisbury, he has built up a farm of 3,000 acres, on which there are some 800 acres of woodland. Lord Radnor is a past President of the Country Landowners' Association and a member of the Royal Forestry Society of England and Wales, and is Chairman of the Rothamsted Experimental Station and of the Institute of Agricultural Engineering at Silsoe, Bedfordshire.

Among his other appointments Lord Radnor is Lord Warden of the Stannaries in the Duchy of Cornwall.

THE PHOSPHORUS REQUIREMENTS OF DAIRY CATTLE

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How much phosphorus is needed by the cow for milk production? What effects do other factors such as calcium and vitamin D have on the absorption and utilization of phosphorus? The writer points to some of the existing work on the subject but suggests that a great deal more investigation could usefully be conducted in Britain on this aspect of animal nutrition.

THE problem of the phosphorus requirements of dairy cattle is perhaps most easily met by considering first of all the needs for milk production, leaving those for maintenance and growth for later review. Nevertheless, although physiological requirements for phosphorus for maintenance and growth are known with less precision than those for milk production, with that one distinction apart, what is said subsequently applies to them also.

Subject to relatively slight variations of composition, one gallon of milk contains 4–5 grammes of phosphorus (9–12 grammes as P_2O_5). It follows, therefore, that a production ration which provides less than that amount of phosphorus for each gallon of milk cannot be adequate. For a time, a cow which is so fed may continue in apparently normal condition, but only at the expense of running up an "overdraft" on its own reserves of phosphorus —chiefly those present in the bones. Like other overdrafts, one of this type cannot be increased indefinitely, the end of such a process being a severe loss of condition, which may be manifest in different ways according to the circumstances. Small overdrafts may be tolerated for short periods; large ones certainly are not. In other words, the animal has sufficient natural resilience to withstand day-to-day variations in food supplies but will not bear prolonged mismanagement.

Four to five grammes of phosphorus per gallon of milk may thus be described as the *physiological* requirement of the cow for milk production, and, since the *dietary* need cannot be less than that, the point to be settled is how great the dietary margin of safety should be. Here it may be said that it is apparently rare for the whole of any constituent of a ration to pass through the intestinal walls of the body, i.e., for the constituent to be 100 per cent digestible. For purposes of discussion it is convenient for the moment, therefore, to assume simply that a ration has been produced of such a nature that the quantity of it fed for the production of a gallon of milk also allows 4–5 grammes of phosphorus to be absorbed through the walls of the digestive tract. What changes in the nature of this ration, other than in its phosphorus content, can influence the amount of the element which is absorbed? Generally speaking, an increase in the amount of calcium (lime) in the ration will produce a fall in the proportion of dietary phosphorus available to the cow, i.e., less than 4–5 grammes of that element will then be absorbed by the bowel. Solely as a milk production ration, the food thus no longer provides a sufficiency of phosphorus.

Importance of the Calcium-Phosphorus Ratio To satisfy the needs of the dairy cow, it is now clear that the milk production ration must satisfy at least two requirements: (a) it must contain at least 4–5 grammes of phosphorus per gallon of milk, and (b) it must have a satisfactory calcium-phosphorus (Ca/P) ratio. Absorption of phosphorus appears to be greatest when the weights of calcium and phosphorus provided in the diet are in the ratio of between 1 : 1 and 2 : 1. As the ratio rises, so the dietary phosphorus becomes less and less utilizable by the animal. Thus a production ration supplying 10 grammes of calcium and 6 grammes of phosphorus (Ca/P ratio 1.66 : 1) will be worsened if its composition is changed so that it then provides 20 grammes of calcium and 6 grammes of phosphorus (Ca/P ratio 3.33 : 1) per gallon of milk. Quite clearly, however, where the ration already contains *less* than 4–5 grammes of phosphorus per gallon, the lowering of its Ca/P ratio cannot *alone* remedy the deficiency: more phosphorus will also have to be provided.

It may be asked whether it is necessary only to make sure that the Ca/P ratio lies within the limits given above, if the amount of the ration fed for each gallon of milk does provide more than the physiological minimum of phosphorus. In order to answer this very practical question it is essential to examine the results of tests which have been made on "standards" for phosphorus requirements.

Most of these tests have been made in the U.S.A. or in S. Africa, and not in Britain. In some trials, only two or three cows have been on test for short periods, but there have been other experiments, as for example those of Hart and his associates [1] in the U.S.A., when as many as forty animals have been studied through three lactations.

The considered opinion of informed American authorities [2] after reviewing such trials is that for the production of one gallon of milk the ration should provide "standard" allowances of 10 grammes of calcium and 7 grammes of phosphorus, the safety margins for the two elements above simple physiological needs thus being about 100 and 50 per cent respectively. Nevertheless, it should be noted that, according to these same American authorities, " data for the evaluation of feeding standards are *very inadequate**", and " the allowances . . . are presented as tentative values". The standards suggested in *Rations for Livestock* [3] differ only in suggesting an allowance of 9 grammes of dietary phosphorus for each gallon of milk, i.e., in providing for British cows a safety margin of about 100 per cent for phosphorus as well as calcium. To understand the caution of the American workers and to arrive at a correct appreciation of the position so far as Great Britain is concerned, other relative factors must now be considered.

Action of Vitamin D Even though the amount of phosphorus provided by the diet is fairly high and the Ca/P ratio a favourable one, it seems to be clear that in creatures ranging in size from a rat to a sheep or a cow, phosphorus is not absorbed from the diet if the animal lacks vitamin D. This has been shown to be true for the dairy cow by Wallis [4]. What then do phosphorus "standards" signify? They mean that under average conditions in *North America*, for example, with the amounts of vitamin D which are there available to cattle, 7 grammes of dietary phosphorus per gallon of milk are likely to be enough. In translating the results of extensive United States trials to the feeding of cattle in Britain, clear

* Present writer's italics.

understanding of the sources of vitamin D for livestock is thus absolutely essential.

Though men, pigs and poultry may derive their vitamin D from fish liver oils, the cow normally has only two sources, namely, the vitamin D produced in her own skin by the action of sunlight upon it, and that which is produced by sunlight on hay. It is important to note that both sources depend upon sunshine, so that the cow is doubly the loser if the sunlight happens to be of low intensity, or of short duration, or both. No common food other than hay appears to contain appreciable amounts of vitamin D.

Vitamin D supply for cattle (as well as for horses and sheep) is thus more closely linked with climate than is the case with any other nutrient. The environmental conditions for American livestock are very different from those which pertain to Britain, for, on any day, the U.S.A., being nearer to the equator than the British Isles, sees the sun climb higher in the sky than it does here : as a result the sunshine there is usually more intense and can produce more vitamin D, both in the cow and in sun-dried hay, than is the case in these islands. Furthermore, other climatic factors are also normally more favourable in the U.S.A. than in Britain. For example, during the best months of the year at one of the sunniest places in England (Kew) clouds obscure the sun for rather more than half of the hours of daylight. Moreover, meteorological data show that even in June some 60 per cent of the area of the sky is overcast, thus further restricting the amount of sunshine, which, scattered by the atmosphere from its direct path from the sun, would otherwise reach the ground from other parts of the sky. In the U.S.A., on the other hand, long, hot summers, with almost cloudless skies, are common over much of the country.

It follows, therefore, that United States recommendations for meeting calcium and phosphorus requirements apply to regions where the vitamin D supply is likely to be much higher than in Britain. Estimates made by the present writer ([5]) suggest that American livestock are probably two to three times better off than British in respect of the intensity and duration of sunlight and the consequent formation of vitamin D.

That some of the early American trials failed to show any advantage in providing cattle with dietary vitamin D, *in addition* to that which they derived from hay and from solar action on the skin, was probably due either to the animals already having a daily sufficiency of the vitamin without any supplement, or to their having stored up vitamin D reserves in their own bodies before the tests began. Cows with no vitamin D reserves and no daily supply of the vitamin behave very differently. Their condition rapidly deteriorates and phosphorus absorption from the intestine ceases, as Wallis has shown ([4]).

Since the absorption of phosphorus from the intestine of a cow may be improved either by increasing the amount of that element in the diet or by raising the animal's vitamin D supply, the dietary needs of the beast can now be extended to include (a) at least 4–5 grammes of phosphorus per gallon of milk, plus a safety margin of an as yet unspecified magnitude, (b) a fairly low Ca/P ratio, and (c) a sufficiently high vitamin D supply.

Recently, Hignett ([6]) has presented evidence to show that a small percentage of British dairy herds is showing diminished fertility, due either to high dietary Ca/P ratios or, pre-supposedly, to too low phosphorus intakes. Hignett suggests that the existing British "standards" for phosphorus requirements are too low. In his work, however, no account was taken of the vitamin D supply of the experimental animals, which were housed and

were never at any time exposed even to weak winter sunshine. As indicated previously, no practicable phosphorus supply seems to be adequate in the absence of vitamin D (4).

Nature of the Practical Problem Where cows are on rations of a high Ca/P ratio, an increase in dietary phosphorus may in some cases improve their condition, but, as Hignett has shown (7), where the ratio is low the provision of additional phosphorus makes the position worse. The demonstration of this type of phenomenon has been reported many times before.

To the present writer the practical issues seem to be the following: (1) vitamin D supply for certain classes of livestock is intimately connected with climate ; (2) on the whole, weather conditions in the British Isles are rather unfavourable for vitamin D production for livestock ; (3) there is little evidence that the common fodders of these islands fail to provide the *physiological* phosphorus requirements for milk production, so that such problems as exist may well involve faulty absorption or utilization rather than real dietary deficiency ; (4) the intimate connection between vitamin D and phosphorus absorption is well established ; (5) vitamin D unlike either calcium or phosphorus, assists the absorption of either element in the presence of an excess of the other ; (6) from the practical feeding point of view, two or three doses of vitamin D per year should suffice for a cow ; (7) attention to vitamin D intake might leave the farmer with greater freedom in the liming of land and in the use of the newer leys ; (8) though the findings of Hignett may concern only a small proportion of British cattle at the moment, it remains true that the drive for more intensive production is likely to increase the number of such problems of faulty utilization.

Conclusions The writer feels that the time is ripe for extensive trials in Britain to determine the present calcium and phosphorus requirements of dairy cattle, now that our agricultural system aims at increasing self-sufficiency in foods for livestock, and at more intensive levels of animal production. Since the general bases for conducting such trials at the lower levels of output have already been studied in a number of countries, more careful scrutiny of nutritional needs peculiar to the livestock of this country are desirable. The animals should be fed the home-produced fodders on which they are now expected to thrive, and should be kept under those climatic and environmental conditions which pertain to the British Isles, and which may well be unique. The ability of British land to produce grass certainly suggests a unique type of environment.

Over-simplification of experimental approach must be avoided. To the very powerful evidence that attention to dietary levels of calcium and phosphorus alone is insufficient to ensure the effective absorption and utilization of these elements, must be added the reported discovery of an organic, anti-vitamin D factor in some green fodders (8). Any trials should thus be conducted not only with controlled vitamin D intakes, but also with attention to the other constituents of the ration. The repeated claim that, even under the favourable conditions of the U.S.A., rickets is prevalent in calves (9) also strengthens the case for a full investigation of the position in these islands. It is useless to produce greater yields of crops, having higher protein contents than hitherto, if the increases are not to be efficiently utilized because of the lack of some nutrient whose existence has been ignored. Last year, workers in the U.S.A. proved that vitamin D-deficient calves, for example, do not utilize protein so well as those receiving sufficient of the

vitamin [10]. Phosphorus requirements thus provide only one aspect of a complex problem in animal nutrition.

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SILAGE QUALITY IN ENGLAND AND WALES

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In view of the increasing use being made of silage in this country, the following summary of the results from samples submitted during the year 1950-51 to N.A.A.S. laboratories for examination for fermentation, dry matter and crude protein contents, should prove of considerable interest to farmers.

FOR many years chemists have examined and analysed animal feeding-stuffs, including silage, in the course of advising farmers on feeding problems. However, it is only since the inception of the N.A.A.S. in 1946 that sufficient information has become available for a useful summary to be made on a country-wide basis. It would not be practicable, in a short article such as this, to present a complete account of all the work undertaken by the Nutrition Chemists of the N.A.A.S. in any one year. Therefore, it was considered that a summary of the work done on silages would be of greatest interest to the farming community. Emphasis has been laid on the production of silage during recent years and the examination of this material forms a large part of the work of Nutrition Chemistry Departments, nearly 8,000 samples having been received during the period April 1, 1950—March 31, 1951, at the various provincial and sub-provincial centres. Much has been said and written about the need for making high protein silage, and the following account gives some indication of the extent to which such silage has been produced.

The examination of silage is concerned with four main aspects : (a) the crop ensiled, (b) the type of fermentation, (c) the dry matter content, and (d) the protein status (and consequent feeding value). It is with these four aspects in mind that this summary has been prepared.

Table 1
Types of Crops Ensiled

	Percentage of Samples
Grassland	66.7
Lucerne with or without grass	7.1
Cereal/Legume	20.7
Kale	0.65
Pea haulm	0.9
Sugar beet tops	0.65
Other crops	3.3

Although the above table does not show the distribution of crops ensiled between the different provinces, as would be expected the different types of farming practised in various parts of the country do influence the relative proportions of samples of different crops from province to province. Thus it was found that in the Eastern Province,* where lucerne and lucerne mixtures are a more common crop than elsewhere, almost 29 per cent of the samples received at the Cambridge laboratories were lucerne or lucerne/grass silages. In the Yorks and Lancs Province, as in the Northern†, Welsh and South-Western‡ Provinces, a very high proportion of the samples was grass silage (76 per cent at Leeds [Yorks and Lancs], and 78 per cent at Aberystwyth, [Wales]). In contrast, only 37 per cent of the samples at Cambridge were from grassland. It is also interesting to observe that, of the small number of pea haulm silages received throughout the country, almost 60 per cent came from the Eastern Province, such silages being derived from the residues of green peas grown for canning.

Types of Fermentation The fermentation type is judged by colour, smell and *p*H (acidity). Silage which has undergone an ideal fermentation is usually yellowish-green and has a slightly acidic smell. Exceptions to this include samples containing red clover which usually develop a brown colour, even though satisfactorily fermented, and kale silages which, although of greenish-yellow colour, rarely lose their original characteristic smell. Most well-made silages have a *p*H within the range 3.8–4.5, although lucerne varies from this in usually having a *p*H around 5.0. Silages made from some of the less common materials may also vary from the normal in respect of colour, smell and *p*H, and still be satisfactory.

Details of the types of fermentation found during the period covered by this summary and of the percentage distribution of these types are shown in the following table.

Table 2
Types of Fermentation

	Percentage of Samples
Satisfactory	68
Underheated	19
Overheated	8
Mouldy/Putrefied	5

* Comprising the counties of Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Huntingdonshire, Lincolnshire (Holland), Norfolk and Suffolk.

† Comprising the counties of Cumberland, Durham, Northumberland and Westmorland.

‡ Comprising the counties of Cornwall (including Isles of Scilly), Devon, Dorset, Gloucestershire, Somerset and Wiltshire.

The characteristics of underheated silage are very well known, more particularly the offensive smell which is very persistent. The colour is usually green to dark green, depending upon the degree of underheating, while its *p*H ranges from approximately 4.5 for a very slightly underheated silage to 6 for a severely underheated silage. Despite the nauseous smell of such silage, cattle will usually eat it, although caution in feeding is normally advocated with silage having a *p*H greater than 5.5. Another point worth making is that some silages in this class are subject to a breakdown of plant tissue, particularly in the leaves, so that they have a slimy feel. The causes of underheating are well known, and discussion of these does not fall within the scope of this article.

Although overheated silage is less common nowadays, it nevertheless presents a serious problem to the farmer who produces it ; moreover, it is one of which he may not be aware. The digestibility of protein in overheated silage is considerably depressed—in fact, very badly overheated silage may contain almost no digestible protein whatsoever. Overheating produces a brown to almost black colour (not to be confused with the brown colour of a satisfactorily-made red clover silage) and a smell which may vary from a pleasant caramel-tobacco in cases of slight overheating to the burnt smell characteristic of a severely overheated silage. These silages, when allowed to get wet, become mouldy and may decompose sufficiently to cause them to be classified in the group to be discussed next.

The figure of 5 per cent for mouldy or putrefied silages does not seem high but, in fact, this means that almost 400 silage samples were received which were in a thoroughly bad condition and unsuitable for feeding to any class of stock. The majority of these silages were found to have a *p*H over 6. There is little that can be said about this group ; such material is better described as muck.

During the latter half of 1950 most parts of England and Wales had a very heavy rainfall, and some silage which had been satisfactorily made was damaged by rain and, in some cases, by flood. Silage washed by water loses much of the preserving substances formed by good fermentation and is consequently subject to attack by undesirable organisms. The result of this is a secondary breakdown with a fairly rapid rise in *p*H and the production of a stable-like odour in which the smell of ammonia may sometimes be detected. In short, water damage leads to the rapid deterioration of silage which originally may have been satisfactory. In Table 2, silages classed as having a satisfactory fermentation include a certain small number of water-damaged samples. In the laboratory, it is possible to distinguish samples with a high *p*H which has been caused by water damage ; although such damage can frequently be detected by the senses.

Dry Matter Categories It has been mentioned already that heavy rain occurred during the period under review. This is, to some extent, reflected in Table 3, from which it will be seen that almost two-fifths of the samples received contained less than 19 per cent dry matter. Since a normal dry matter is considered to be between 19 and 25 per cent, the results would seem to indicate that greater attention should be paid by farmers to the sealing of silos and possibly to the provision of better drainage. Provided a silo is adequately filled and sealed, rain, however heavy, should not influence the quality of the contents. A very wet silage means the feeding of greater quantities and the carting of an unnecessarily large weight of water with the silage.

Table 3

Dry Matter Categories

Percentage Dry Matter	Percentage of Samples
Greater than 31	4.3
27-30.9	6.9
23-26.9	17.5
19-22.9	32.1
15-18.9	31.4
Less than 15	7.8

Crude Protein Distribution The crude protein figure is probably the one with which most farmers who use the National Agricultural Advisory Service are concerned. The protein status of a silage is most important, but in considering feeding values the protein figure must be tempered by the type of fermentation which has taken place, while the amount to be fed must be largely governed by the dry matter content of the silage.

It is the practice of Nutrition Chemists to classify silages under four main headings according to the protein content—namely, Very High Protein, High Protein, Medium Protein, and Low Protein. Very high protein silage has a crude protein content of over 18 per cent of the dry matter and has not been subject to much breakdown of the nitrogenous constituents by under-heating or putrefaction. A silage containing this percentage of crude protein is seldom overheated. High protein silage contains 15–17.9 per cent crude protein in the dry matter, medium protein silage 12–14.9 per cent, and low protein silage less than 12 per cent. Where evidence of overheating exists, a silage is normally relegated to the protein class below that in which its crude protein figure would normally place it. In the event of *serious* overheating, *any* silage would be relegated to the low protein class, since overheating seriously reduces the digestibility of protein.

Both the very high and high protein classes of silage are milk production foods, the former requiring balancing with a cereal and the latter being itself balanced for this purpose. The medium protein class is normally considered as a part maintenance and part milk production feed, whereas the low protein class is considered as a hay replacement only.

Table 4

Amount of Crude Protein in Dry Matter

Percentage Crude Protein	Percentage of Samples
Greater than 18	12.9
15-17.9	22.2
12-14.9	32.4
Less than 12	32.5

As the above table shows, almost 13 per cent of the samples received contained more than 18 per cent crude protein, and about 22 per cent of the samples contained between 15 and 17.9 per cent crude protein, so giving a total of about 35 per cent in the " milk production" classes. Thirty-two per cent of the samples contained 12–14.9 per cent crude protein, and formed the "part milk production and part maintenance" class : the remaining 33 per cent contained less than 12 per cent crude protein. Thus the feeding values of the year's silage samples were fairly evenly split between the " milk production " silages, the " part maintenance and part production " silages and the " hay replacement or maintenance quality " silages.

Summary About two-thirds of the silage samples received and examined by the Nutrition Chemistry Departments of the N.A.A.S. during the year 1950–51 were found to be satisfactorily fermented, but, owing to the rainy season, about two-fifths of the total were found to be excessively wet. Protein values were found to be fairly evenly distributed over the whole range of values normally encountered and it is pleasing to note that about one-third of the samples represented silages which were of dairy cake quality or better. The results indicate, however, that more attention could be paid to the effective sealing and adequate drainage of many silos.

SOIL STABILIZATION FOR FARM ROADS

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On suitable soil and for suitable traffic, soil stabilization offers a cheap means of constructing useful roads on the farm.

TODAY, when farmers are mindful of improving their fixed equipment, farm roads are very much in the news, and lately attention has been focused on roads constructed of stabilized soil. Road-making in the traditional way is apt to be an expensive business, and any method that will reduce costs is to be welcomed, but an impression seems to be growing that the soil stabilized road is the answer to all problems on farm road construction. This is unwise for there are snags, and it may be helpful to examine them.

Stabilization aims at effecting a lasting improvement in the supporting power of a soil by adding to it other soils and/or certain stabilizing agents. The addition of cohesive soils such as clay to those deficient in binder, and vice versa, is known as "mechanical stabilization." The stabilizing agents most commonly used are bitumen, tar or Portland cement. In this country, owing to our uncertain climate, stabilization with tar or bitumen is tricky, and cement is the only agent likely to be of value to the farmer at present. It is with soil-cement that this article is concerned.

There are two questions that must be answered before anyone starts work on a soil-cement road : " Can my soil be stabilized? ", and " If it can be, is a soil-cement road really what I want ? "

Ensure that the Soil is Suitable . . . It must be realized that not all soils can be stabilized satisfactorily ; generally speaking, a soil heavier than a silty clay is likely to be unsuitable, or put in another way, a soil on which it is easy to get a fine tilth for small seeds is likely to be satisfactory. Some soils rich in organic matter give trouble in hardening, others do not ; the reason for these varying results is not yet clear. The net result of all this is that anyone contemplating a soil-cement road should test the soil before starting work.

For highway or building estate work, an engineer will send samples of soil to a specialist laboratory, but it is doubtful whether farmers need go to this expense. Traffic demands on farm roads are, generally speaking, far

less than those on a highway. In any case, much of the information given in a laboratory report will be of no use to those laying their own roads ; for example, information on the optimum moisture content for compaction will be of no use to the farmer who has no instrument with which to test the moisture content of the soil at the time of compaction. When all is said and done, there is only one way to find out whether a soil can be stabilized, and that is by trying a sample mix. This is, in fact, what laboratories do, only instead of making a number of trial strips on the ground, they make up a number of samples " on the bench", to find out the amount of cement giving the best result coupled with the optimum moisture content. As will be seen later in this article, this is not essential.

It is neither difficult nor expensive to try out a sample strip; if a strip of, say, 5 yards × 3 yards is laid *in situ*, the worst that can happen is that about half a dozen bags of cement and the labour will be wasted. Even then the cost is likely to be considerably less than a laboratory fee, and it gives the farmer the chance of seeing how the job is done in practice. Alternatively, a few samples can be made up in old, round ½ lb. cocoa tins.

The procedure is as follows :

1. Collect about 7 lb. of soil from the site of the proposed road. The sample should be representative of a layer 6 inches deep.
2. Pulverize the soil into a fine crumb and weigh out six samples of 1 lb. each.
3. Into each of three samples, thoroughly mix 1½ ounces of cement (10 per cent by weight). There are now three samples of soil cement mixture and three samples of soil.
4. By adding water, bring the consistency of one sample of mixture and one sample of soil to that described on p. 374 under the heading "Watering".
5. Take one of the remaining samples of mixture and make it rather wetter than the first ; take the last sample of mixture and add rather less water than was added to the first. Do the same with the remaining two soil samples. There are now three different moisture contents, A, B, and C, in the six samples ; i.e., one of the soil-cement mixture and one of soil at A, one of each at B, and one of each at C.
6. Take the tins, slightly oil them round the inside, and stand them on a flat, smooth surface (a board or piece of flat steel sheet).
7. Put each of the six samples into a tin and label it ; put a little in at a time and ram each layer hard.
8. Leave the six tins in a cool dry place for seven days to "cure".
9. At the end of the curing period, shake each sample out of its tin and compare the soil-cement samples with the soil samples. If the stabilization process has been successful, the soil-cement samples will be hard, and when tapped gently with a hammer will "ring", making a noise similar to that when two flints are tapped together. If the stabilization has not been successful, the noise will be dull and probably the cylinder will break. The hardest of the soil samples will show the moisture content at which compaction is best.

At this stage common sense should tell whether the soil can be stabilized or not, but if a further test is desired, the soil-cement samples may be immersed in water for 24 hours, at the end of which time they should be unaffected.

If the samples have not hardened at the end of seven days, the failure may be due to organic matter in the soil ; it is then worth while repeating the test with the addition of ½ ounce of hydrated lime (2 per cent) to each sample. If this works, it means that, when the road is laid, 1 cwt. of hydrated lime must be added to every 5 cwt. of cement. The lime must be evenly distributed and thoroughly mixed with the soil ; the job is best done as a separate operation before the spreading of the cement.

Remember that wherever the soil changes in the line of the road, the test must be repeated.

There is another more drastic test which, if the result is interpreted with common sense, is interesting. In a laboratory a sample cylinder is put through a crushing test in an appliance which is, in effect, a jack coupled with a dial which reads in pounds pressure per square inch. The layman cannot get a result in such terms but he can, more as a matter of interest than anything else, see what his samples will stand in the way of pressure by trying to jack up his car with it. The cylinder should be placed between boards before pressure is applied—don't let the cylinder itself rest on the jack and against the axle. If you intend trying this test, you must be careful, when ramming a sample into its tin, to see that the top of the rammed surface is flat and smooth. The difficulty with this test is that it is not easy to get an even bearing under an axle so, if a cylinder breaks, don't make up your mind that your soil will not stabilize. The failure may be due to uneven pressure. If the car can be raised you can be sure that you will get a good road.

Another method is to squeeze a cylinder in a bench vice if you can find one with jaws which will open 4–5 inches.

However, if anyone particularly wants to have his soil tested by a laboratory, the names and addresses of laboratories undertaking this work can be obtained from the Committee Land Agents of County Agricultural Executive Committees. To save money, it is as well to make quite clear to the laboratory that information on two points only is wanted: (1) whether the soil can be stabilized, and (2) if it can be, how many bags of cement will be required for a road of given length and width.

In a laboratory report, the amount of cement required is expressed as a percentage of the dry weight of soil (compacted) to be stabilized; it varies between 6 and 12 per cent. For those who are doing their own road-making it is quite safe to work on a figure of 10 per cent. This means that for every 100 lb. of soil, 10 lb. of cement must be added. Soils vary in density, but for this purpose they can be classified under three heads—light clay, sandy loam and sandy gravel—and it may be taken that 1 cwt. of cement will stabilize, to a depth of 6 inches:

2.25 sq. yards of light clay
2.14 sq. yards of sandy loam
2.0 sq. yards of sandy gravel

. . . and the Road is the Kind you Want

On the question of the suitability of soil-cement roads for farms, it is necessary, as in all road-building, to be clear on the purpose of the road. It might be argued that because soil-cement roads are being built successfully on housing estates and highways, the process must be satisfactory for farms : this is not so. There is no standard farm road ; no two farms are alike, and often two roads on the same farm will have to stand up to different demands. It is true that the weight and frequency of traffic on a highway are far in excess of those on the average farm road, but the majority of vehicles on a highway are on rubber tyres. Farm roads, on the other hand, have to carry a variety of road-destroying traffic—for example, tractors with spade lugs, vehicles with steel-shod wheels, and cattle. The cloven hoof is a great destroyer of roads. In addition, a farm road may have to put up with animal urine and droppings, and with mud dropped by vehicles and implements coming off the fields.

The surface of a soil-cement road must be protected by a dressing of tar or bitumen and chippings. Such a dressing may be damaged by droppings, urine and mud if they lie on it for any length of time ; it will not stand the continual scraping and washing down necessary for keeping the road clean.

It follows that a soil-cement road is unlikely to be successful outside a cowhouse or implement shed, where there is a concentration of cattle and vehicles. Tracked and spade-lugged tractors will damage any road in time ; indeed they should be kept off roads as much as possible.

To sum up, where the bulk of traffic is on rubber tyres (for example, on an access road linking the highways with the homestead) a soil-cement road is likely to prove cheap and efficient. Moreover, the job is essentially agricultural, and one which can easily be done with farm labour and (with the possible exception of rolling) farm tools.

There are six stages in the making of a soil-cement road :

1. Preparing the site. This includes marking out the line of the road, removing all vegetable matter and shaping the surface for drainage.
2. Reducing the soil to a fine tilth.
3. Spreading and mixing the cement with the soil.
4. Watering (if necessary).
5. Compacting (rolling).
6. Surfacing with bitumen or tar covered with grit or chippings.

Experiment at Wye College In 1951 the Ministry decided to find out whether a soil-cement road could be laid successfully with farm labour and farm tools, and at what cost. In co-operation with the principal of Wye College, a road 45 yards × 3½ yards was laid on October 16. The site selected runs through the Horticultural Department and alongside an existing bitumen-surfaced road which the College had planned to widen. Compared with the general run of farm roads, the traffic here is heavy and frequent ; this was the main reason for selecting the site. The soil is brickearth. Here is the story of how the road was laid.

Preparing the Site. Normally the first job is to remove turf or other vegetable matter. In this case the site to be stabilized was plough land and all that was necessary was to bring the level up to that of the existing bitumen-surfaced road—hence the kerb (to contain the soil) which can be seen in the photographs in the art inset. It must not be thought that a kerb is inherent in a soil-cement road ; the kerb here is peculiar to this road.

Getting the Tilth. The road was first ploughed and then the soil was pulverized with a market-garden rotary hoe from the Horticultural Department. The result was excellent, the soil being thoroughly pulverized to a depth of about 6 inches (8–9 inches of loose soil) after three passes of the hoe.

There is no doubt that a rotary hoe is the best tool to use, since a *very fine tilth* is needed. An intimate mix of soil and cement is essential and there must be no lumps. On friable soils fixed-tine cultivators and discs have been used successfully, but the job takes longer.

Spreading and Mixing. The bags of cement were "spotted" along the road, broken open, and the cement spread as evenly as possible with rakes and shovels. Then the rotary hoe was put over again. Mixing should continue until the mixture is a uniform colour, and we got this in three passes.

Watering. It is important that the moisture content of the mixed soil and cement should be right. It is not difficult for the layman to judge the right consistency of the mixture ; when a handful is squeezed it should just hold together in a cake. It should not be possible to squeeze water out of it nor must it crumble away when the hand is opened ; it is better to err on the wet side.

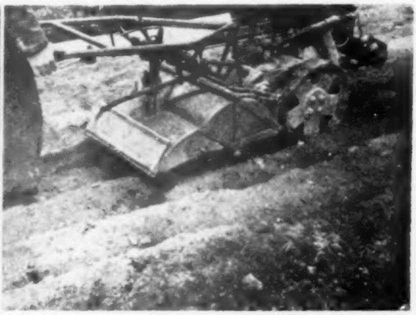
A SOIL-CEMENT ROAD

The Finished Job

Compared with a macadam road at about 10s. per square yard and a concrete road at 15–20s. per square yard, a soil-cement road is cheap.

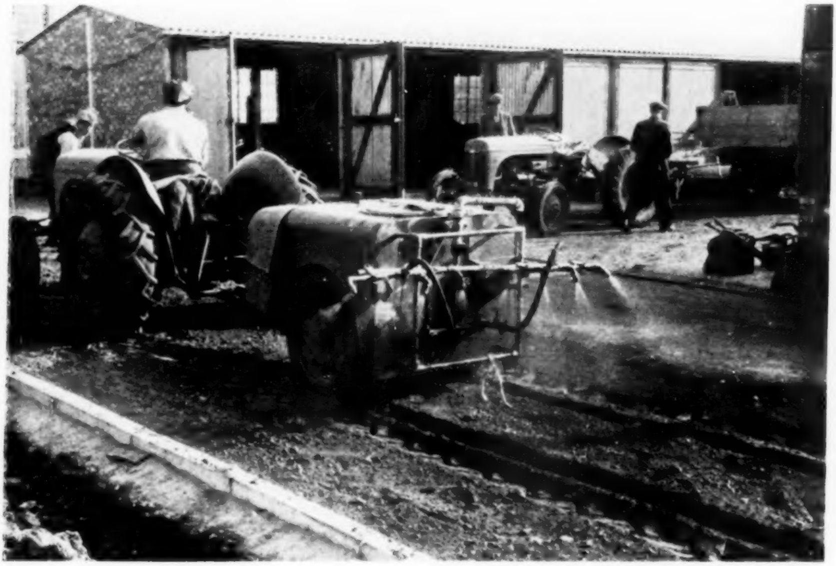
Building the Road

Spreading the cement



An intimate mix of soil and cement is essential

(The kerb seen is not normally required–see text)



Watering with a fruit sprayer.   This was not satisfactory until

......lances were fitted

Rolling is best done with a 2½-ton road roller but

......at Wye, a farm roller filled with concrete and weighing about 35 cwt. was used

The finished road before surfacing with bitumen emulsion and chippings

The emulsion was sprayed on with a hand-operated sprayer

At Wye we decided to use a fruit sprayer. At first the water was applied through the nozzles at the back of the machine, but this was not successful as the area covered by each nozzle was too small. The lances were then fitted and these did the job well. During watering, the rotary hoe was kept going until the right consistency was obtained ; it is very necessary that the water should be well mixed with the soil-cement to its full depth.

The adding of water will often be the most troublesome operation. It is obviously impossible to say how much will have to be added to a given length of road but it is quite possible that in a very hot, dry period a road may need up to 5 gallons per square yard. On some farms this may well prove an exacting task, and it may be possible to save much carting by doing the initial pulverizing during dry weather and doing the actual stabilization after the next rain.

If a sprayer is not available, the next best thing is a water-cart (or tank in a trailer) with a hose outlet to which a rose spray nozzle has been fixed. Improvization is nearly always possible but the important thing is that the water should be applied evenly.

Rolling. Proper compaction, which must follow as soon as the mix is of the right consistency, is most important, and it is generally held that a road roller weighing at least 2½ tons is necessary. This means hiring from a contractor or the Highway Authority, which is not always easy to organize economically ; not often will a whole road be constructed at once—the job is more likely to be done as time permits—and several visits of the roller are expensive.

We were determined not to hire in this experiment so we decided to borrow a flat farm roll used on the village cricket pitch. It was 7 feet long with a diameter of 24 inches and was filled with concrete ; its weight was about 35 cwt. We knew its use was a gamble.

The roll was drawn by a rubber-tyred tractor. At first the tractor marked the road badly and the roll did not take out the marks, but later, after the roll had been up and down a good many times, compaction improved. After about 1½ hours rolling, the road appeared to have gone down well. The next day a few rough places were levelled with a hand rammer, and with the exception of surfacing, that finished the job.

Surfacing. A soil-cement road should be surfaced as soon as possible after the curing period (about one week) and preferably before traffic is allowed to use it. In this case cold bitumen emulsion was sprayed on by contractors using a hand-operated sprayer, and the chippings were applied by home labour. The job of applying the emulsion could have been done equally well by home labour using watering cans, but it happened that the contractors were on the spot surfacing another road so it was decided to let them do it.

The road cost 4s. 3½d. per square yard ; 3s. 1d. of this is the cost of the road itself and 1s. 2½d. is the cost of surfacing.

The road has now been down for nearly a year and today it is in good fettle. Of course, a year is a short time in the life of a road but we have high hopes for its future ; it stood up well to last winter's traffic and it should be over the dangerous period now. A small area failed where the soil-cement joined the existing road. This did not worry us as the joining of two roads of different construction is always a tricky job and the breakdown was obviously caused by lack of compaction ; the roll rode up on the edge of the existing road. Compared with a macadam road at about 10s. per square yard and a concrete road at 15–20s. per square yard, our road is cheap.

FOGGAGE AND SILAGE AS WINTER FEED FOR SHEEP

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The results obtained from a trial carried out last winter at the Grassland Research Station show that sheep allowed to graze on timothy foggage for a period each day did much better than a similar group confined to a paddock and fed on silage.

THE demand for more meat has emphasized the value of sheep on pasture, particularly as a scavenging flock complementary to dairy and beef cattle. Approximately 30 per cent of the folded arable sheep flocks in this country are reported by Ashby (1) to be uneconomical as a unit of production, and from this it follows that one of the greatest assets of grass feed—its low cost of production—must place it in a vital position in the shepherding system.

Overwintering on pasture provides the opportunity for economies in flock maintenance. Griffith and Hutton (2) have shown that herbage grown at low cost in the late summer and autumn can be conserved as a standing crop to provide feed in the winter for store sheep. Sheep so overwintered will fatten rapidly in the following spring, and the system offers an alternative to fat lamb production.

The use of grass as foggage for outwintering beef stores at the Grassland Research Station has already been described by Hughes (3), while the conservation of excess summer grass as silage is also an integral part of winter feeding at the Station. It was therefore a simple step to the trial to test the comparative value of foggage and silage as supplementary feeds for outwintered tegs which took place in the winter of 1951–52.

Sixty Suffolk × Halfbred tegs (90–110 lb. live weight) were drawn from the Station flock, and were divided into two equal groups, each having the same average weight. In the course of the experimental period from January to April 1952, the first group of 30 tegs was fed foggage as a supplementary feed, and the second group was given grass silage. From early December 1951 until the experiment began, the 60 tegs were allowed to graze on a 16-acre grass ley sown in 1948. When the feeding trial began on January 10, 1952, this area was equally divided to form two holding paddocks, and one group of sheep was confined to each. The whole field had been grazed as bare as possible, so that little herbage was left for grazing.

An area of approximately 8 acres of leafy timothy (chiefly S.48, with some S.50), sown in 1948 in 20-inch drills, was put up for foggage in early September 1951, and 4 cwt. "Nitro-Chalk" was applied per acre. This area was subsequently divided into six paddocks of approximately 1⅓ acres each, to be grazed in turn. Sheep in the "foggage" group were allowed 5 hours grazing each day on the foggage, and returned to the holding paddock for the remainder of the day. To measure foggage consumption, samples of the herbage were taken from each paddock before and after grazing.

The grass silage, of moderately good quality, with 13.8 per cent crude protein in the dry matter and a *p*H of 4.8, was weighed out each day and placed in two racks in the 8-acre holding paddock of the silage-fed group of sheep. Residues from the previous day were removed and weighed, and

representative samples taken throughout to determine dry matter consumption and chemical composition. All 60 sheep were weighed, without fasting, three hours after sunrise on three consecutive days every two weeks in order to estimate the effect on live weight of the two feeding treatments.

Fluctuations in Live Weight The average live weight of the two groups of sheep at each weighing is shown in Table 1. While running together on the holding paddock during the preliminary test period before the trial began, the average weights of the two groups differed very little. On the last date of weighing during this period the group averages showed a slight decline. From the time supplementary feeding began on January 10, until the end of February, the group of sheep fed on foggage showed little change. This group then increased in weight until, at the end of the feeding period on April 17, an average gain of 14.5 lb. per head had been made.

The silage-fed group lost weight from January 22, and by March 4 they had lost an average of 5.4 lb. per head. Subsequently the group increased in weight to give an average gain over the whole period of 4.2 lb. per head.

Table 1

Fortnightly Liveweight Records of Sheep given (*a*) Timothy Foggage and (*b*) Grass Silage as Supplementary Winter Feed

Date of Weighing		Average Weight of Groups	
		Foggage	Silage
	1951	*lb.*	*lb.*
Preliminary Period ..	November 14	101.3	100.8
	December 5	101.3	101.1
	December 18	101.7	101.5
	1952		
	January 8	98.7	99.1
	1952		
Experimental Feeding Period ..	January 15	98.4	98.6
	January 22	99.4	99.4
	February 5	99.2	98.5
	February 19	99.4	96.8
	March 4	100.6	93.7
	March 18	102.8	94.6
	April 1	106.5	98.2
	April 17	113.2	103.3
Average gain over feeding period		14.5	4.2

From the end of January, the sheep in the "foggage" group were more thrifty and the condition of the fleece very much better than in the group fed on silage.

As will be seen from Table 2, the ewe and wether tegs, which were equally divided within the two groups, gave a marked difference in liveweight response under the two feeding treatments. On average, the wethers gained almost twice as much as the ewe tegs.

Table 2

Average Liveweight Gain of Ewe and Wether Tegs during the Feeding Period

Supplementary Feed	Wethers *lb.*	Ewes *lb.*
Foggage	17.8	11.1
Silage	6.1	2.3
Average gain	11.95	6.7

Consumption of Supplementary Feed The timothy foggage was readily eaten by the sheep, which spent a high proportion of their daily allowance of 5 hours in grazing. Details of daily dry matter consumption show that during the experimental period of 3½ months from January to April, the average daily intake of dry matter from the foggage paddocks was 1.8 lb. per head, with a maximum of 2.7 lb. per day on paddock No. 2 (see Table 3).

The silage, made from grass-clover herbage in the flowering stage, was not readily eaten by the second group of sheep. These attained their highest average daily consumption of 8½ lb. wet weight per head in the fourth week of feeding, during which the intake on one day reached a maximum of 9½ lb. per head. The average daily intake of dry matter as silage over the whole period was 1 lb. per head.

Consumption of silage was related to the growth of grass in the holding paddock, and was only slightly affected by the weather which, on the whole, was dry but cold over the course of the feeding period. Light falls of snow on January 26 and March 28 were followed by small increases in average consumption during weeks 4 and 13 (Table 3). Relatively high, weekly mean morning temperatures of 47.6°F. and 52.4°F. in weeks 11 and 14 were accompanied by a reduced consumption of silage. The lower intake recorded during the latter half of the feeding period was probably due to a certain amount of growth taking place in the grass of the holding paddock. This was grazed by the sheep in preference to the less palatable silage. During this same period, the higher protein content of the timothy foggage in the last two paddocks to be grazed indicated that growth was also active in this area.

Effect on Worm Burden Faeces were collected from all the sheep during the last weighing in April 1952, to detect, by means of faecal egg counts, any differences in the parasitic worm burden arising from the two different feeding systems. Average egg counts for the "foggage" group and "silage" group were 38 and 126 eggs per gramme of fresh faeces respectively. Allowing for differences in faecal consistency, the count of 38 eggs per gramme in the former group is low, and indicates a level of worm infestation not likely to reduce liveweight gains. In the "silage" group, the count of 126 eggs per gramme is large enough to be a contributory factor in the smaller liveweight gain of the group. This difference in worm burden could have arisen from the greater time spent each day by the silage-fed sheep in the holding paddock, together with the closer grazing of this paddock partly resulting from the low palatability of the silage. This type of management would tend to produce a higher intake and build-up of infective larvae. The "foggage" group, on the other hand, spent much of their time on fresh paddocks, while the holding paddock in this case was less intensively grazed because of the higher consumption of palatable foggage.

Table 3

Consumption and Quality of Supplementary Feed, and Mean Weekly Temperatures (January 10—April 17, 1952)

Foggage Paddock No.	1		2		3		4		5			6			Average
Yield of dry matter *lb. per acre*	2,449		2,047		1,777		1,744		1,950			2,162			2,065
Percentage crude protein in dry matter	14.6		14.0		14.7		12.3		14.5			14.9			14.2
Average daily consumption of dry matter *lb. per head*	2.6		2.7		1.0		1.8		1.6			1.2			1.8
Silage (pH = 4.8) Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	—
Average daily wet weight intake *lb. per head*	4.1	6.4	7.2	8.5	6.8	6.2	4.6	4.6	4.8	4.0	2.9	3.5	4.1	2.3	5.0
Percentage dry matter in silage ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
Percentage crude protein in dry matter	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13.8
Average daily consumption of dry matter *lb. per head*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0
Mean weekly temperature at 9 a.m. (G.M.T.) *deg. F.*	39.3	34.2	28.9	35.2	34.2	36.8	37.5	43.6	44.7	43.1	47.6	34.9	45.7	52.4	—

Wool Yield and Summer Live Weight When both flocks were shorn on May 19, 1952, there was a difference of 1 lb. per head in the yield of wool from the two groups. The foggage group yielded an average fleece weight of 8.1 lb., compared with 7.1 lb. from the group fed with silage. Changes in weight were also recorded during the summer grazing period. On July 23, the average weight of the "foggage" group was 9.4 lb. higher than that of the silage-fed sheep.

Needs for Suitable Winter Feed Phillips (4) states that winter food for the flock, particularly from January to April, is important in relation to output of meat from sheep. As an alternative to slaughtering lamb in the autumn, a suitable system of overwintering would enable higher carcass weights to be realized early the following year, and at the same time helps to level out seasonal fluctuations in this source of our meat supply. In addition, a wool clip may be taken before slaughter.

The influence of sex on liveweight gains found in this trial confirms carcass dissection data of Pálsson and Vergés (5) using Suffolk × Halfbred lambs. They state that the ewe lamb fattens more readily at an early age than the wether, and suggest that ewe lambs not wanted for breeding should be used for early lamb production. Only wethers should be kept as stores, as they are capable of greater growth during the store and fattening periods than the ewes.

Griffith and Hutton and others have reported limited consumption of silage by sheep. Thomas (6) has indicated a maximum daily intake of 8–10 lb. fresh weight per head, while Stawart (7) emphasizes the necessity for the silage to be made from short, young grass for successful sheep feeding.

The Value of Foggage The conservation of leafy, winter-green strains of grass as foggage can supply suitable feed during these months. In this trial, Suffolk × Halfbred tegs gained an average live weight of 14.5 lb. per head from January to April on a daily ration of timothy foggage. A second group of similar sheep gained an average of only 4.2 lb. per head and consumed a total of 6½ tons of silage in the 3½ months. Early spring growth in the foggage was reflected in the liveweight gains of March and early April. Controlled grazing of the foggage allowed early spring recovery to take place following grazing in winter. The resulting early bite of herbage was available in March and April for other sheep that acted as followers to the experimental flock. In contrast, the holding paddock carrying silage-fed sheep was overgrazed, and any growth of herbage was eaten off as it grew, thus lowering the rate of early spring growth.

For full utilization of foggage, controlled grazing is essential. In this trial, small paddocks and rationing by time were used when grazing the first four paddocks. In the last two paddocks, however, controlled grazing with electric fencing moved daily, was successfully carried out. For the first day four strands of wire were used on each fence to ensure that the sheep rapidly became accustomed to the electrified wire. Subsequently, two strands of plain wire at heights of approximately 10 inches and 30 inches were found adequate to restrain the sheep on a very narrow strip of foggage.

Although these results cover only a single season, they confirm the value of foggage. As with store cattle, the electric fence enables such herbage to be better utilized.

The writers are indebted to Mr. C. R. W. Spedding of the Grassland Research Station for data on worm infestation.

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LINSEED CULTIVATION TRIALS IN EAST ANGLIA, 1948-50

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Time and rate of sowing, row width, manuring and weed control are all important factors in successful linseed cultivation. The trials by the Norfolk Agricultural Station and the N.A.A.S. give some useful pointers to growers.

THERE are three major problems in the cultivation of linseed. First, the plants grow very slowly in their early stages and are likely to be smothered if grown in weedy land ; secondly, the crop may be seriously damaged by the Flax Flea beetle ; and, finally, it is difficult to harvest unless conditions are very favourable. All these problems are, in fact, closely related to the time of year when the crop is drilled, but while it may be claimed that one particular sowing period is the most suitable for overcoming one or two of these disadvantages, the chosen time appears unavoidably to expose the crop to risk from one of the others. Thus by sowing in May, the weed seedlings in the surface layers of the soil can be killed before the crop is drilled, and soil and weather conditions should encourage rapid growth. But the crop may be checked by drought and Flea beetle attack, and harvest will be late in the autumn. On the other hand, linseed drilled in March and early April is in most years less likely to be damaged by drought and the Flax Flea beetle, and it is usually harvested in favourable weather. But if the land is cold and wet when the linseed is sown, the crop will grow slowly and is likely to be smothered by weeds. In any case, there is little opportunity for killing weeds before drilling. Of course, annual weeds and the Flea beetle can very largely be controlled by chemical means, but this increases the cost of growing.

In addition to this uncertainty about the best time to drill, there is some doubt as to the best seed rate or row width for the crop. It has been suggested that the usually recommended rate of 80 lb. per acre is unnecessarily high, and that weed control and harvesting would be easier if the crop were grown in 4-inch instead of the more customary 8-inch rows.

In an attempt to answer some of these problems, a trial was laid down at Sprowston in 1948 and continued in 1949 and 1950. An interim report was published in this JOURNAL after the first year's work.* Similar trials were also started by the N.A.A.S. in the Eastern Province.

Trials at Sprowston and Suffolk (N.A.A.S.) At Sprowston, the main comparisons were between drilling in mid-March, mid-April and mid-May. At each time there were three seed rates (25, 40-56, and 75 lb. per acre) and two row widths (4 and 8 inches). The variety Royal was grown each year. All plots received a basal dressing of fertilizer equivalent to 1½ cwt. sulphate of ammonia, 2 cwt. superphosphate and ½ cwt. muriate of potash per acre, applied just before the seed was drilled. The soil at Sprowston is a light-medium loam overlying brickearth, and the average annual rainfall is 25 inches.

A series of N.A.A.S. observation plots were also laid down in 1948 at different centres in East Anglia to study the same aspects of linseed cultivation. This work was continued in 1949 and 1950, but only on light sandy land in East Suffolk. At each centre one series of plots was used to study the effect of time of drilling on yield, and the response of the crop to a general dressing of fertilizer. The drilling dates chosen were March 15, April 15 and May 15 ; half of the plot sown at each of these times received no fertilizer, while the other half received the equivalent of 1 cwt. sulphate of ammonia, 2 cwt. superphosphate, and 1 cwt. muriate of potash. All these plots were drilled in 8-inch rows and at a seed rate of 80 lb. per acre. Another series of plots was laid down to study the effect of seed rate and row width, but these factors were not combined with the times of drilling as in the Sprowston trials Again, however, 4-inch and 8-inch rows were used. On the narrow rows, the seed rates were 60, 80 and 100 lb. per acre, and, on the wide ones, they were 40, 60 and 80 lb. per acre. These plots were drilled in the middle of April. As at Sprowston, the variety Royal was used exclusively in the N.A.A.S. trials.

The results of the Sprowston and N.A.A.S. trials are given in the following tables. It will be seen that in both cases there were great variations between one year and another.

Table 1

Yields in Relation to Time and Rate of Sowing and Row Width
(Corrected to 14 per cent Moisture Content)

SPROWSTON TRIALS	1948	1949	1950
Time of drilling		*cwt. per acre*	
March	10.5	9.1	—
April	11.0	9.6	3.3
May	10.9	14.6	5.0
Sig. Diff.	—	—	—
Row width			
4-in.	11.0	10.5	4.2
8-in.	10.6	9.9	4.2
Sig. Diff.	—	0.6	—
Seed rate per acre			
lb.			
25	10.1	9.8	4.5
50	11.1	10.7	4.0
75	11.2	10.2	4.1
Sig. Diff.	0.9	0.7	—

* Linseed Trial—1948. P. N. HARVEY. *Agriculture*, 1949, **56**, 19-21.

Table 2
Yields in Relation to Time of Sowing and Manuring

N.A.A.S. TRIALS	W. Suffolk 1948		E. Suffolk Mean 1948 and 1949		E. Suffolk 1950	
	No Manure	With Manure	No Manure	With Manure	No Manure	With Manure
	cwt. per acre					
Time of drilling						
March 15 ..	10.5	15.0	10.1	12.2	—	—
April 15 ..	14.0	13.0	8.9	10.8	3.6	3.6
May 15 ..	8.2	3.4	3.4	4.6	1.5	1.8

Table 3
Yields in Relation to Row Width and Seeding Rate

N.A.A.S. TRIALS	Herts 1948	W. Suffolk 1948	E. Suffolk Mean 1948 and 1949	E. Suffolk 1950
	cwt. per acre			
Row width				
4-in. ..	17.9	13.4	10.2	3.0
8-in. ..	18.2	11.9	9.5	3.5
Seed rate				
Light ..	18.7	13.0	10.4	2.8
Medium ..	17.61	12.8	10.3	3.6
Heavy ..	17.8	11.7	8.8	3.3

Field Observations All the plots were drilled at the correct time under good seedbed conditions, and the linseed developed satisfactorily, except on those plots drilled in March 1950. At Sprowston these plots were destroyed by birds, while in E. Suffolk conditions were so wet and cold that the linseed failed to develop and had to be re-drilled. The linseed drilled in May was never seriously checked by late spring droughts and, in all cases, grew more quickly than that drilled earlier in the season. In all years, however, either the April or May drillings were attacked by Flea beetle, and had to be protected by dusting with DDT powder. The March drilling was never seriously attacked by this pest.

Every year as many weeds as possible were killed before the linseed was drilled. At Sprowston the seedbeds for the April and May drillings were prepared in early March, and any weeds that grew were killed by shallow cultivations before drilling. Although some weeds were killed before the April plots were drilled, it was only when drilling was delayed until May that a really clean crop of linseed could be grown without resort to chemical weed control. The April 1948 drilling at Sprowston was dusted in June with a selective weed-killer, and a very satisfactory control of weed was obtained. No chemical weed-killers were used in the N.A.A.S. trials, and again fewer weeds grew on the late-drilled plots, but with each drilling the plots which had received fertilizer were the most weedy.

Lodging occurred after heavy rainstorms in both 1948 and 1949. In 1949 the April drilling at Sprowston was lodged in July; in 1948 the May drilling, both at Sprowston and in W. Suffolk, was lodged by storms in August. It has been suggested that there is a correlation between the amount of lodging that occurs and the stage of maturity of the crop at the time of the storm. In these trials the worst lodging occurred on the drilling that was at the most susceptible stage when the rains fell. The plants in the fertilized plots were more heavily lodged than those in the plots receiving no fertilizer.

The trials at Sprowston were normally cut with a binder and left in swaths in the field until fit to thresh with a combine fitted with a pick-up attachment. The N.A.A.S. trials were cut with a binder, stooked in the field, and then either threshed direct from the stook or stacked and threshed later. In most years, the March drilling was fit to cut with a binder by the middle of August ; the April drilling was about a fortnight or three weeks later, whereas the May drilling ripened unevenly and at a time which depended largely on seasonal conditions. In a wet season like 1948 it was still very green when the April drilling was cut, whereas in 1949 (a dry season) the two lots of linseed ripened about the same time. In the N.A.A.S. trials, the use of fertilizer caused the May drilling to ripen even later and more irregularly. This was the reason for the very low yield from the May-drilled plot which received fertilizer at W. Suffolk in 1948. It was found that if late-drilled linseed was cut before it was ripe it matured quickly in the swath and was soon fit to combine, but in a showery autumn it was often difficult to get the swath sufficiently dry to combine satisfactorily, even though the linseed was fit. Thus in 1948 and 1950 the May drilling at Sprowston was not combined until October. Harvesting conditions were particularly bad in 1950, and this was the main reason for the low yields and high experimental error obtained in that year.

In none of the years did the different seed rates or row widths markedly affect the growth of weeds or the susceptibility of the crop to lodging. No attempt was made at inter-row cultivation on the 8-inch work, however, as it was felt that this would have been inconsistent with modern farming practice. It was noticed on several occasions that cutting with a binder was easier on the narrow rows than on the wide ones, particularly when cutting across the line of drilling.

Some Conclusions from the Trials The results indicate that under the conditions prevailing at Sprowston the highest yield of linseed will normally be obtained from May drilling. This is probably because such linseed experiences the most favourable conditions for quick growth after germination and suffers least from weed competition, owing to the cleaning that is possible before drilling. In 1948, however, when the land warmed up early in the spring, and the weeds on the April-sown plots were controlled by chemical means, the yield was identical with that from the later drilling. But the increased yield from late drilling is more than counterbalanced by the delayed harvest with all its attendant risks and difficulties, and it would be impossible in practice to take the same trouble over harvest as is done with an experimental crop. It must be remembered, however, that the variety used in all these trials (Royal) normally ripens rather late in the season, and late drilling may be a more practical proposition with an earlier-ripening variety.

Conditions for the N.A.A.S. trials were quite different. For the most part they were carried out on light, sandy soil which warmed up earlier in the spring and contained far fewer weed seeds. In these circumstances, there was less reason for delaying drilling and, in fact, such a course might well have been disastrous. Such light land dries out very quickly during the summer, and any crop that is not well established then is likely to be permanently checked. Moreover, it was found that very late crops ripened unevenly and that much of the seed on the earlier-ripening plants in the plots was taken by birds or shed before the later plants were ripe. But the failure of the March drilling at E. Suffolk in 1950 emphasizes that, even on this land, it is dangerous to drill the crop too early in an unfavourable season.

Two conclusions can be drawn from these results. Firstly, it is pointless to drill linseed before the land has warmed up in the spring. It appears that on very light land March drilling is satisfactory in all but abnormally late seasons, whereas on slightly heavier soil it is probably safest to wait until the middle of April. Secondly, it is seldom wise to delay drilling until the middle of May, despite the advantages of weed destruction, because of the consequent difficulties at harvest time. Every effort must be made to grow linseed on clean land, and if this is impossible the weeds will have to be controlled by chemical means. Similarly, growers must always be prepared to dust linseed with DDT against the Flax Flea beetle, for attacks are likely to develop most years on an April-drilled crop.

The results from the N.A.A.S. plots suggest that linseed will give an economic response to about 4 cwt. of balanced fertilizer, but this quantity must be adjusted in the light of the condition of the land and the residues from the previous crop. Certain difficulties, such as a stronger growth of weeds, delayed and uneven ripening, and an increased chance of lodging may, however, arise from the unwise use of fertilizers with this crop.

The trials have given consistent evidence about the effect of seed rate on yield. The heavy seedings of 75–100 lb. per acre give no heavier yield than the medium rates, and may, in some circumstances, lead to a reduction in yield. On the other hand, although the light seed rate did, on occasion, give the heaviest yield, such a low seeding leaves little margin for error, particularly with early drilling. Probably 50–60 lb. per acre is the optimum seed rate for the crop. In 1949, counts of the number of plants, stems and seed heads per foot-length of row indicated that with the lower seed rates an increased number of seed-bearing stems per plant compensates for the fewer plants per unit-length of row.

In the majority of cases the linseed grown in 4-inch rows gave a slightly heavier yield than that in the 8-inch rows, but in only one year was the difference big enough to be statistically significant. There was evidence that cutting was easier when the crop was grown on narrow rows, but there was no confirmed evidence that the growth of weeds or the standing ability of the crop were affected by row width. Bearing in mind the difficulty of obtaining drills that will work on 4-inch rows, it seems that these advantages of narrow rows are so slight as to be of no practical importance.

The writer wishes to thank the Experiments Committee of the N.A.A.S. (Eastern Province) for the use of unpublished experimental results ; also the field officers in the Province, especially those in E. Suffolk, who carried out many of the trials.

THE WEST RIDING RHUBARB INDUSTRY

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Throughout Britain there are many small areas which, because of certain natural advantages, specialize in the production of a particular crop. One such area is to be found in the West Riding where, using methods which have scarcely changed over the last seventy years, market gardeners force large quantities of rhubarb for the early season trade.

AGRICULTURE, and particularly horticulture, provides many instances of different forms of husbandry practised by those whose job it is to wrest food in one form or another from the fertile soil of our island home. The choice which a farmer or grower makes is largely influenced by environment, soil conditions, climate and the availability of a suitable outlet for the produce grown. This is particularly true of the forced rhubarb industry, which thrives in an area of Yorkshire lying mainly between Leeds and Wakefield. Here, this crop may be said to dominate the policy of a flourishing community of market gardeners whose holdings spread among the shadows and smoke of an intensive industrial area.

The housewife accepts forced rhubarb as a very welcome change in the menu in the early months of the year but has not much interest in its production. Farmers know it must be grown somewhere and, while horticulturists in most parts of the country are aware that "those chaps in Yorkshire" do force rhubarb, many have little knowledge of the technique involved. I want, therefore, to give you an intimate peep into the very heart of the industry so that you can appreciate how it came to be concentrated in so small an area of Yorkshire, and why it has succeeded.

First of all, we must go back to great grandfather's time to learn something of its early beginnings. Without doubt, the discovery of the fact that it was possible to produce rhubarb out of season by providing the right growing conditions artificially, was made some 120–130 years ago. Some of the earliest rhubarb to be forced was in fact grown in the spare room of a market gardener's house. A hundred years ago growers were taking rhubarb roots into darkened, heated glasshouses in winter and producing from the crowns an artificial growth, which found a ready market locally. The roots were very carefully lifted by hand, placed on some sacking and carted into the greenhouse on a barrow. The scope was limited and the output small, but a start had been made which clearly indicated the possibilities. In the days when transport was largely by horse or horse-drawn vehicle there were many more racecourses than there are today, and it is said that one of the first rhubarb farms in the West Riding was started in the shadows of a disused grandstand. The long, low, black-roofed forcing sheds in use today first came into being over seventy years ago, and little change in the fundamental principles employed has occurred in the lifetime of present-day growers.

It may well be asked how the industry came to be located in the West Riding. There are, however, a number of factors, which together help to make this the ideal environment. In the first place, rhubarb is a moisture-loving plant and must have a plentiful supply of water throughout the active period of its growth. This requirement is satisfactorily met, since the clay subsoil found in these parts forms a moisture-holding medium from which the roots can draw their needs. Free drainage is also necessary, since it is important that water should not lie in the top layers of the soil. Being so

near to large industrial centres, there is, however, a good supply of ashes available to growers for drainage purposes. These are spread 9–12 inches deep on land intended for rhubarb and then ploughed in. Since soil is removed with roots lifted for forcing, ashing is repeated, as far as the supply will allow, every three to four years with a layer from 4–8 inches deep. The crop also prefers acid conditions in the soil, so the industrial deposits from smoke and fumes are just to its liking. It has been estimated that some 10 cwt. of soot are deposited annually on each acre of land in this locality. That is a lot of soot and a not insignificant amount of nitrogen.

This industrial environment also provides two other conditions favourable to rhubarb growing. Firstly, the smoke-laden atmosphere screens the sun to some extent, thereby reducing the number of hours of sunshine and lessening the intensity of the sun's rays. The amount of moisture drawn from the crop on a sunny day is therefore less than it might be in other parts of the country, and the plant does not flag. Secondly, the industrial atmosphere ensures that the tops of rhubarb roots which are to be forced die back sufficiently early to allow the crowns to be lifted and housed in the autumn.

In the Field The rhubarb land is prepared by ploughing-in a heavy dressing of farmyard manure, if available, or sewage sludge if it is not. Feeding with fertilizers must be as generous as the pocket will allow, since the crop occupies the land for three years and during that time it has to store food in its roots for eventual use in the forcing shed. Some growers apply up to 20 cwt. per acre of a complete fertilizer. If a good basal dressing is not possible, growers will often top-dress the crop with a balanced fertilizer or some form of nitrogen. In these parts, rhubarb often follows broccoli, a crop which occupies the ground for two years, but which is cut in May and June, thus leaving ample time for the preparation of the land for the autumn planting of rhubarb. Broccoli being a crop which is well manured, there is often a good residue of which the rhubarb makes good use.

In the field, rhubarb setts are planted in rows 3 feet apart with 3 feet between each plant. This gives some 5,000 roots per acre. The method of planting adopted is to drop the setts in a furrow from a cart or trailer and then plough in. Propagation is vegetative and consists of splitting three-year-old roots into setts. A good sett must have one healthy bud with sufficient root to support it. Usually four setts are obtained from an average root, but the number may be increased to six or seven from particularly large ones. Inter-row cultivation is practised until the plant is big enough to overcome weed competition.

For three years the crop grows and is allowed to die back, for there is little trade for green rhubarb, and roots which are intended for the forcing sheds will have their cropping capacity reduced if pulled green. Any roots from which a crop of green top has been taken must be left for a further year's growth before being forced. During the war, when the shortage of fruit led to the offer of an attractive price, a good deal of green rhubarb went to jam manufacturers, but the practice is now frowned upon, except where the roots are to be used only for propagation purposes or when growers have no forcing sheds.

Lifting for forcing starts after the third year's growth has completely died back. July sees the growth past its best, and during each succeeding month the top growth gradually disappears until the dormant stage is reached. The crowns must not be lifted until dormant, and, as mentioned earlier, it is because conditions in this area bring about the necessary dormant

period at a relatively early stage that forcing is possible. Lifting starts, according to variety and shed space, any time from the third week in October. Some growers plough-out the roots with ordinary tackle, although a special rhubarb plough has been manufactured and is being used on many holdings. It has a wide, deep breast with three strong tines attached which, since the soil falls off the end of the mould-board, throw the roots clear of the soil. A horse-drawn plough follows the rhubarb plough round and skims the top few inches from the unploughed land so that the roots fall clear of the furrow and are not buried again The roots are then forked into rows out of the way of tractor and plough to await carting. There is an old belief that frosted roots give a better crop than those not so affected, but there is no real proof of this.

Forcing in Sheds Shed sizes vary considerably, but the most satisfactory is considered to be in the region of 400–500 square yards, say 35 yards by 12 yards. There are many both larger and smaller, but this size is perhaps the handiest and can be used for mushrooms when the rhubarb season is finished. Various materials are used for building the sheds. Wooden ones, covered on the outside with felt, are often seen, but they suffer from the disadvantage that the part near the ground is subject to rot where the roots are packed against it. Some growers avoid this by putting the shed on a low brick foundation, while others build entirely in brick. The tendency today is, however, towards the use of precast material. The roof is normally of wood covered with felt, and is made as low as possible to conserve heat and thereby economize in fuel. Nevertheless, the height should be sufficient to allow a horse and dray or tractor and trailer to pass through the shed and so cut down the amount of hand labour required when filling. Asbestos sheets, which are more readily available than wood, have been used for roofing but, owing to resultant fluctuations within the shed, they have not been found satisfactory. If, however, this material is lined with timber, it is every bit as efficient as wood and felt. Although more costly to erect than wood, it has the advantage that it does not require maintenance such as tarring and re-felting.

It takes approximately an acre of three-year-old roots to fill a shed, more from light land, less from strong. On occasions, roots are forced at two years, and though a greater number of such roots are needed to fill a shed, the crowns pack more closely and a heavier yield per square yard is obtained, even with a shorter cropping period. Whatever the age of the roots being forced, they are packed as tightly as possible into beds about 4½ feet wide on either side of the shed. Filling is completed by extending the beds into the road left down the centre until only a narrow path remains. In this way, the sticks can be pulled without the worker having to stand on the bed and so risk damage to the crown. Enough soil falls from the roots on to the trailer when carting to fill in the crevices between each crown. This is the only soiling done.

As soon as a shed has been filled, all light is excluded by packing doors with sacking, for the crop has to be grown in total darkness to protect the colour of the stick and control the size of the top. Heating begins at once, a temperature of 60°F. being the aim. The method of heating has undergone some changes over the years, but there are more growers using the old flue system than there are using hot-water pipes. Originally, small areas were heated by directing the warmth from a fire through ordinary sanitary pipes. This developed into a bricked flue covered by small concrete slabs with a cross-section of approximately a square foot. Coke fires, placed so that

they can be fed from the outside, supply heat which is drawn through the flue by the draught from a chimney at its far end. In some sheds, the flue runs the full length of one side ; in others, there is a separately-fired flue running from each end almost to the centre of the shed. The disadvantage of the latter system is that the heat is not uniform throughout the area, and the crop becomes ready for pulling at different stages, according to its position in relation to the flue. For a man with only one shed this may not be a disadvantage, since, in this way, the profitable period of the crop can be spread over a longer time, but to a man who wishes to force two crops in a year it means throwing out the first crop before all the roots are exhausted. Greater uniformity of cropping results from hot-water pipes all round the shed and sometimes overhead. Some of the bigger growers have now gone a step further and installed automatic stokers.

Harvesting by Candlelight Once heating is started, the grower is able to obtain a fairly reliable estimate of the crop by noting the amount of fibre running from the roots into the soil packed between them. Pulling begins 4–5 weeks after firing starts, and goes on for between 8 and 12 weeks, according to the vigour of the roots. The peak generally comes between the seventh and ninth week after heating starts. The crop must be well watered once a week, but apart from that it needs little attention. Most of the pulling is done by candle light, the candles being mounted on the top of long portable sticks which can be sited anywhere. Each stick of rhubarb is pulled separately by gripping it at the base and twisting it out so that the crown is not damaged. Considerable skill is necessary in deciding when pulling may begin. The sticks should be still erect and the leaves small. If pulling is delayed, the sticks may become bent, lose colour and the leaves will open, resulting in a loss of appearance.

The weight of crop obtained from a forcing shed varies considerably from year to year, and there are several factors which influence it. For instance, lifting at the right stage is all-important. If the crowns are taken up a few days too soon, the yield may be seriously depressed. Early frosts assist in avoiding this error, however, since they accelerate die-back and the resultant dormant stage. The number of seeders in a crop materially affects performance in the sheds too. More seeders are thrown in some years than in others (1951 was particularly bad), and each seeder takes the place of a main crown from which the forced root sends up growth. Yields may also be affected by Crown Rot disease, the worst enemy this crop has. One-year-old roots may appear perfectly healthy, but if the disease is present it becomes more and more apparent in the second and third years and eventually affected roots will fall to pieces when ploughed-out to reveal a rotten brown mass beneath the crown. Slightly affected roots may be forced, provided they are destroyed after removal from the shed.

When the roots are exhausted they are taken out and stacked. If conditions allow, they are usually burnt—a job which lasts weeks. The ash is then spread on the land. Where burning is not practicable, the roots are often left to rot, although a few growers still continue the old practice of ploughing back forced roots into the land in rows, leaving them for a further three years, forcing them once more, and then dumping. This may result in a 75 per cent crop in the second forcing but it is risky if the stock has any symptoms of disease. Still other growers cart the forced roots on to land intended for cauliflowers and plough them in as plant food. As a precaution against the possible spread of disease, the soil from the shed is carted on to land which will not grow rhubarb that year.

Two varieties predominate in the West Riding, namely, Victoria and Prince Albert. The length of time these have held their own can be gathered from the fact that they were named after Queen Victoria and her Consort. It is generally recognized that Prince Albert can be forced at two-years-old but that Victoria must be left for another year. The former variety is lifted first, usually from mid-November onwards, the date for lifting Victoria being a fortnight later at the beginning of December. A Cheshire grower has brought out a variety called Timperley Early which can be lifted for forcing in the third week in October and will therefore be ready for pulling before Christmas, but although some is grown in this area, the acreage is very small. Its chief drawback seems to be a very short dormant stage which lasts only from 7 to 14 days.

Marketing—by Weight The bulk of forced rhubarb is marketed in the first three months of the year, but marketing goes on right into May, although the late crop is considered to be something of a gamble. The very earliest rhubarb appears in the shops just before Christmas, though the total weight is small. Filling of the sheds is so arranged that the harvest is staggered, and sheds become ready for pulling at different periods. In an average season about one ton of forced rhubarb will be pulled from every 1,000 roots.

Before the war, a special train left Leeds every night between January and March laden with hampers of forced rhubarb consigned to Covent Garden, which acted as a clearing house. War-time exigencies interrupted the service, but it was started again immediately after the war. The railway companies used to look very favourably on this traffic, for the rhubarb was loaded one day and delivered and paid for the next. The increased use of road haulage has probably affected both the weight carried by rail and the destination, but London is still considered to be the main centre for distribution, even though nowadays considerable quantities are also sent to Birmingham, Manchester and Newcastle. The tendency is, of course, to seek new outlets and go further afield, but this is limited by two important factors; first by the fact that rhubarb is a perishable commodity which rapidly loses appearance and must therefore be marketed daily, and secondly because sixty miles is considered to be the maximum economic distance for which road transport can be employed. The most satisfactory way to market the crop seems to be to send regular supplies to a selected market, particularly as the freight charges are naturally proportionately less for large consignments.

Before 1940, most of the trade was in hampers containing four or six dozen bundles, which was considered a handy pack for a single shop. Price control and consequent sale by weight, introduced as a war-time measure, killed this practice but, in any case, most growers nowadays would not like to revert to bunching. The consumer is also better served by today's marketing system, for when rhubarb was sold by the bundle the weight of each bunch varied considerably. The pack most commonly used now is of loose sticks in 2- and 3-stone paper-lined boxes covered with corrugated cardboard and tied down.

Rhubarb growing is not confined to Yorkshire ; there are centres in Scotland, Essex and Cheshire, to name but three, but by far the greatest acreage (amounting to some 5,000 acres) are grown in this part of Yorkshire. There is one feature about the West Riding industry that has no counterpart anywhere else in the world, namely, the Annual Rhubarb Show organized

by the Leeds and District Market Gardeners' Association. This usually takes place in Leeds at the end of February and has been staged for over thirty years. Rhubarb is the only product exhibited and the date is arranged so that all varieties will be available.

It will by now be obvious that there is rather more to this rhubarb business than the man who covers a few roots with an old bucket or two at the bottom of his kitchen garden would think, and if he could mingle with market growers somewhere in this vicinity he would quickly learn that the chief topic for discussion is rhubarb—the forced variety.

FARMING AFFAIRS

Fresh Sugar beet Tops How valuable an asset sugar beet tops are for stock-feeding is not as widely recognized among arable farmers as it might be. All classes of stock relish this succulent feed fed green, and do well on it. They should, however, be introduced to it gradually. In protein equivalent, starch equivalent and dry matter, sugar beet tops are very similar to marrowstem kale, and indeed they can replace it in the ration, especially from October until Christmas, on a pound for pound basis. Compared with mangolds and swedes, they contain more dry matter and are richer in protein and starch equivalent.

	D.M.	S. Equiv.	P. Equiv.
Sugar beet tops	16.0	8.6	1.2
Marrowstem kale	14.0	9.0	1.3
Mangolds	12.0	6.2	0.4
Swedes	11.5	7.3	0.7

The actual nutritive value of the tops varies with the proportion of leaf to crown; the latter contains most of the feeding value, but of course any overtopping of the root would be far outweighed by the loss in the tonnage of beet sent to the factories. Any appreciable lapse of time between topping and feeding will also reduce the value of the tops by loss of sugar. Although it is desirable to allow the tops to wilt before feeding to reduce the content of oxalic acid in the leaves to safe proportions, they *must* be fed before decomposition begins—if possible, within two to three weeks of topping. If the tops have to be left in the field, they stand less risk of deterioration from rain and frost if they are kept in heaps, rather than in rows. The tops should also be kept free from soil—contamination that is usually the result of careless knocking or carting of the tops, or rain splashing. Dirty tops cause digestive troubles, and indeed on sandy land such contamination can be very dangerous to stock.

The belief held by some farmers that fresh beet tops cause scouring is usually valid only if the tops are not wilted before feeding. An additional precaution is to feed chalk with the tops—at the rate of 2–3 lb. per ton. Any tendency to scour can be corrected by reducing the quantity of beet tops in the ration and feeding more hay. It is wise not to feed fresh beet tops too heavily to dairy cows, otherwise there may be a taint in the milk.

With *dairy cows*, it is best to cart off the tops and feed them in controlled quantities in yards or, as shown in our cover picture, on pasture. Up to 50 lb. of tops per head daily may safely be given, and this quantity fed with 10 lb. of medium quality meadow hay and 4 lb. of oats will provide for maintenance and one gallon of milk. Feed the tops immediately *after* milking to avoid risk of taint.

Fattening bullocks can safely receive up to ½ cwt. of tops a day—an allowance that will help offset the costive character of large quantities of coarse fodders. Beet tops are particularly valuable for feeding in the early stages, especially when cattle on autumn grass are waiting to go into their winter fattening quarters.

Up to 15 lb. of tops per head daily can be fed to *fattening pigs* receiving a basal allowance of meal, in replacement of approximately 2 lb. meal.

A mature *sheep* will eat 14–21 lb. of tops a day, and although, as was shown in trials at Sprowston, beet tops do not fatten quite so well as do swedes, it is a useful feed.

But don't feed beet tops to young stock; it will almost certainly scour them.

Farming Cameo : 24. Pembrokeshire Pembrokeshire, with approximately 331,700 acres of agricultural land, forms a compact peninsula in south-west Wales. In general, it is lowland in character with a prominent highland region—the Precelly range—dominating the north-eastern hinterland. From the 800 feet contour, which contains the higher parts of the range, there is a steep fall in all directions to the more gently undulating slopes which terminate seawards in the colourful sea cliffs.

The county provides a remarkable example of the great variation in environment which can occur within a relatively small area, for as many as three or four completely different sets of soil and rainfall conditions can be found here. Thus the northern half of the county is covered by medium to heavy silty loams which contain varying degrees of boulder clay, gravel and sand, whilst the southern portion is intersected with numerous fertile belts of Carboniferous Limestone, Old Red Sandstone, Millstone Grit and Coal Measures. Again, while the county benefits from the mild and early influence of a maritime climate and conditions are generally favourable for early growth, differences in relief and degree of exposure result in considerable variation in rainfall and the effects of frost and wind. Rainfall may be anywhere between 30 and 60 inches a year, and the incidence of frost increases gradually from the temperate but windswept coastal areas to the higher interior.

The relatively large number of smallholdings in the county adds further diversity to the types of farming and the systems of management adopted. Some 66 per cent of the 5,163 farms in the county are under 50 acres and only 7 per cent are larger than 150 acres. Of the 278,000 acres of clean land in the county, there are about 78,000 acres of tillage land, 146,100 acres of permanent pasture, 53,900 acres of temporary pasture and 53,600 acres of rough grazing. The stock carried has increased in recent years and now amounts to 103,200 cattle, 25,000 pigs, 99,100 sheep, 4,600 horses and 519,500 head of poultry.

Although there is this great variety in farming practice, three main systems stand out: (a) mixed farming in the coastal regions, with early potatoes and horticultural crops playing an important role in the rotations, (b) dairy farming in the centre and north-east and, (c) cattle rearing and corn production in the intermediate areas.

The mixed farming is associated with the free-working types of soil on the limestone, Old Red Sandstone and the lighter soils of the north-west. The main crops are oats and mixed corn (42,211 acres) and early potatoes

(9,257 acres). The double-cropping potential of the early potato land is exploited to the full, and considerable acreages of Italian ryegrass, kale, rape and swedes are grown as catch crops, together with some broccoli for market. Fertilizers are used to a notable extent and, on the better farms, yields of 25–35 cwt. per acre of grain, 6–8 tons of early potatoes (in early June) and 14–16 tons of sugar beet, are normal. The rearing of cattle (mostly Herefords) for beef and the fattening of lambs on the by-products of the arable rotation, form the main livestock enterprises on these farms, but intensive dairying, coupled with bacon and poultry production, has begun to replace the traditional systems with marked success.

Dairy farming is common in the northern and eastern parts of the county. The association of high rainfall and heavy soils favours vegetative growth and the production of milk; heavy stocking is a characteristic, and grassland is generally of good quality. On the better farms, there is a remarkable degree of self-sufficiency in feedingstuffs, and it is common to find heavily stocked farms carrying high yielding cows which, apart from some purchased concentrated protein foods, are entirely dependent on their own resources.

In the mainly grassland districts, however, hay still forms the basis of winter keep for cattle, although large quantities of silage have been made on many farms during the last few years; in addition, an increasing quantity of dried grass is becoming available from the two co-operative and thirteen private driers in the county. A substantial acreage of cereals (51,000 acres) and forage crops (14,000 acres) are grown to augment the winter feed. Considerable progress has been made in the methods of farming in recent years, resulting in an increase in sales of milk from 9 million gallons in 1939 to 23 million gallons in 1951.

In the upland districts, cattle and sheep rearing are the major enterprises. The losses suffered in the 1947 blizzard have now been restored and, with the assistance now available under the Hill Farming Act and the Marginal Land Scheme, some of the rough land is being reclaimed so that more stock can be carried.

Extremely good progress has been made in recent years in improving the health and quality of the stock in this county. The efforts made to eradicate tuberculosis over the last decade have been noteworthy, and at present about 70 per cent of the cattle are attested. On October 1, 1952, the eastern part of the county became part of the first Tuberculosis Eradication Area to be declared in England and Wales, and the remainder of the county will be added to the Area in about a year's time. The dairying districts are already an important reservoir for healthy, good quality cattle and now, after years of endeavour, the complete eradication of bovine tuberculosis in the county is in sight.

W. H. Jones,
County Agricultural Officer

Eradication of Bovine Tuberculosis in Denmark In the spring of this year, Denmark was able to proclaim complete victory in the battle to eradicate bovine tuberculosis from her 200,000 herds. At the same time, the Government was in the favourable position of being able to guarantee that all the Danish butter and cheese exported is produced from the milk of tubercle-free animals. The announcement marks the culmination of an arduous and costly campaign which is particularly noteworthy for the close co-operation achieved by the Danish agricultural industry.

Credit for starting the campaign belongs to Professor Bernhard Bang who, some sixty years ago, saw that, by using the tuberculin test of Robert Koch to diagnose infected animals, by isolating newly-born calves and healthy cattle, and by ruthlessly weeding out infected cattle, it was possible gradually to build up healthy herds. Progress at first was slow. Some 80 per cent of herds were infected, and thirty to forty years elapsed before any real advances were made. Gradually, however, farmers, veterinary surgeons and dairies co-operated to achieve systematic eradication.

Up to the early 1930s, the effort was entirely voluntary and much of the cost of weeding out had fallen on individual farmers and the dairies. Between 1930 and 1940, however, further legislation was introduced to provide compensation for the slaughter of reactors, and subsidies for tuberculin tests; the cost being met largely from a slaughter levy and, later, from an export levy on cows and calves. Under this stimulus the campaign gained ground. In 1934, a register of attested herds was started; by 1935 a rearing centre for tubercle-free cattle had been established; 1942 saw 71 per cent of all herds attested, and finally, in 1948, the Danish authorities were able to announce that 99 per cent of their herds had been attested and that the goal was in sight.

The story of this remarkable achievement is told in full in a booklet entitled *The Campaign against Bovine Tuberculosis in Denmark and its Eradication*, published by the Federation of Danish Dairy Associations. Copies are obtainable free from the Danish Agricultural Producers Information Service, 71–72 Piccadilly, London, W.1.

The Agricultural History Society Throughout the greater part of our history, the greater part of our race have devoted the greater part of their energies to the service of the farm. Yet the literature of our economic countryside is curiously disappointing. Admittedly, certain aspects of our rural history, such as the manorial system and the enclosures of Tudor and Hanoverian times, have produced minor libraries. Admittedly, certain more specialist studies take an unquestioned place on any academic bookshelf. Yet, broadly, he who turns aside from the familiar path which leads from Tusser to Tull, from Townshend to Coke, will soon find himself involved in something painfully like exploration. The farm has received markedly less attention from the professional historians than, say, the coal-mine, the railway or the law-court.

The causes of this neglect are numerous and interesting. But high among them, surely, is the inability of the farm to settle comfortably in the province of any generally recognized type of historian. The literary scholar, the lawyer, the geographer, the economist, the scientist can each claim his share of the past of our rural economy and for various reasons team-work is seldom a practical proposition. Indeed, the best illustration of this general "fragmentation" is the inevitable tendency of specialist or local pieces of research to appear in specialist or local periodicals which are for the most part beyond the ken of the average reader.

Such is the background to the Agricultural History Society which came into provisional existence at a meeting held at the Science Museum, South Kensington, on September 25, 1952, under the chairmanship of Sir James Scott Watson, C.B.E., Chief Scientific Adviser to the Ministry of Agriculture. About 90 people, representing all aspects of rural life and work, were present, and apologies for absence were received from many who were unable to attend.

In the interesting discussion which followed, during which Professor Slicher Van Bath of the Netherlands "Agronomisch-Historisch Institut" sketched the work of his bureau and of the Netherlands Agricultural History Society, it was agreed that such a society should not limit its scope to purely agricultural history, but rather that its sphere of interest should be extended to other aspects of rural life, such as land tenure and the domestic side of country life. It was also considered that the publishing of a journal should be the most important part of the society's activities and this could be reinforced by occasional meetings ; in short, the society should act as a clearing-house for information.

A committee was elected to prepare a constitution for the Society and make arrangements for a general meeting to be held at Reading next spring, when a new committee would be appointed. Sir James Scott Watson was elected Chairman of this constituent committee and Mr. J. W. Y. Higgs, Secretary, the other members being Mr. Frank Atkinson, Mr. G. E. Fussell, Mr. Alexander Hay, Mr. W. E. Minchinton, Mr. ffrancis Payne, Professor Edgar Thomas and Mr. R. Trow-Smith.

Anyone interested in rural history who would like further information about the Society should write to Mr. J. W. Y. Higgs, The Museum of Rural Life, 7 Shinfield Road, Reading. *C.N.H.*

BOOK REVIEWS

The Grass Crop. DR. WILLIAM DAVIES. Spon. 26s.

This book sets out to present the story of Pasture from its humble beginnings, when forests were cleared and a "sward" took ground, up to the present-day range of grass swards. Development was slow until about the middle of the seventeenth century, when the pace seemed to gather momentum. The introduction of a rotation in crops with red clover and later of "ray" grass, the work at Clifton Park and more particularly at Aberystwyth, appear as some of the significant landmarks on the road to our present quality swards.

The ecology of natural swards the world over have been studied—the author is much travelled in his researches—and the influence of soil and climate in relation to the grazing animal in characterizing the various pastures have been carefully traced. The ecology of the various grades of British grassland are described in even greater detail.

Careful consideration has been given to ley farming from its early initiations to the modern simple and complex mixtures. A useful list of seed mixture recommendations is appended. Ley farming receives the attention its importance deserves ; one feels the greater emphasis in the author's comments, due to his connection with the pioneering of ley farming.

Those interested in seed production will find useful guidance and help in this section of grass enterprise.

Following a chapter devoted to the role of herbs in pasture, Dr. Davies has given rightful space and consideration to our present information on the mineral nutrition of herbage.

The main theme of the book is the influence which herbage has in relation to the soil and to the animal, but attention is drawn to the importance of the interaction of the biotic factor in this trinity—a matter fundamental to all growth and soil fertility. Most grass husbandmen are familiar with the production aspect of grass, but the utilization of grass leaves much room for improvement, and Dr. Davies rightly dwells on better management which in turn can affect so favourably the soil fertility. In the better utilization of the grass sward of improved herbage strains, coupled with judicious fertilizing, Dr. Davies visualizes far greater possibilities for the grass crop in this country.

In these critical days when the emphasis is on increased food production, this book is particularly valuable and opportune. What Dr. Davies puts forward deserves serious consideration in our farm planning. Very telling figures are presented for the output of milk and meat from well-managed grass. As a crop, with its meat and milk potential and indirectly its influence on soil fertility, grass can contribute more than any other crop to our self-sufficiency.

The book is intended for all students of grass, and cannot but prove to be a stimulus to grass practice. It deserves to be widely read, and the author and publishers are to be congratulated on its timely appearance. *H.R.W.*

National Institute for Research in Dairying Report, 1951. 3s.

At Shinfield, fundamental work on milk production and distribution is carried out alongside shorter-term investigations of the practical problems in dairying, to the benefit of both. Many points of practical interest occur in this report ; for example, trials of the different teat-cup assemblies available commercially show marked differences in milking efficiency, particularly at the stripping stage. It is of interest to note that the factors in the design of milking machine clusters which control stripping efficiency seem to be quite different from those which control milking rate. Mastitis studies at the Institute are indicating that the faster the inherent milking rate of a cow the more liable she is to mastitis infection. Further investigation of the losses sustained in milk fat with a diet lacking sufficient roughage, shows that some concentrated foods depress milk fat, whereas some do not ; thus the relation between a low diet of roughage and the butterfat content of milk is still only partly understood.

Fresh evidence relating to the decline in the average solids-not-fat content of milk in recent years points to the decline being due mainly to a deterioration in the quality of the rations given to cows. It is noted elsewhere in the report that there is no regular association between high levels of butter fat and high levels of solids-not-fat in milk, hence it follows that a breeding policy for improved milk quality based only on milk fat tests cannot be expected to improve the level of solids-not-fat in the milk of many cows.

Interesting experiments with the feeding of antibiotics to pigs are reported. The results suggest that pigs fed on a basal diet of vegetable protein only will respond considerably to small additions of antibiotic substances, and their liveweight gains compare well with pigs fed on a basal diet of animal protein without the antibiotic supplement. Similar experiments are in progress at many centres in this country.

Further progress is being made at Shinfield with rheological measurements of cervical secretions in diagnosing pregnancy and some types of infertility in cows.

More accurate information on the losses entailed in making silage is now likely to be obtained at the Institute with the setting up of eight 20-ton capacity tower silos.

Copies of the report are obtainable from the Secretary, National Institute of Research in Dairying, Shinfield, Reading.

A.J.L.L.

Flora of the British Isles. A. R. Clapham, T. G. Tutin and E. F. Warburg. Cambridge University Press. £2 10s.

As the authors say in their preface, " The reason for the addition of yet another Flora to the long series which began in the seventeenth century is perhaps best explained by a brief historical survey". Especially is this so with this work which bears so many of the best characteristics of its ancestors, whilst being entirely new, and embodying the results of modern work.

The first of the series of books for the " beginner and amateur " to which this new work is heir was George Bentham's *Handbook of the British Flora* (1858). Revised in 1886 by Sir J. D. Hooker, who also wrote a Flora himself (*Student's Flora of the British Isles* (1870)), it gave us the " Bentham and Hooker " so widely used for the last three decades. But the seventh edition, revised by A. B. Rendle (1924), is now twenty-eight years old, and the present authors have performed a much needed service in giving us so worthy a successor. Bentham's Flora introduced the " artificial key", which was carried on to the seventh edition, and is found in a new form here. The " outlines of botany " in which Bentham described the characters and terms used in his "key" and the text, does not appear in this book, but is replaced by a glossary in which it is much easier to find the meaning of a term quickly than in the old "outlines". A first impression is that these terms in the new key will present more difficulty to the non-specialist than those in the old one.

The choice of species names is level-headed, and follows strictly (in the Latin) the rule of priority. The writers have made full use of modern knowledge, such as the work of the geneticists in the definition of species, and have integrated the work of ecologists, plant hunters and taxonomists which had accumulated during the past thirty years.

A companion book of illustrations is on the way, but there are here, interspersed in the text, drawings of parts to help in the differentiation of related species.

The 1,591 pages are very thin, and it will be interesting to see how they and the waterproof binding stand up to field work.

It is interesting to know that the needs of agriculturists have been borne in mind in compiling what will surely become the standard British Flora for all but the most specialized botanical work.

D.L.

The Complete Poultryman. ALAN THOMPSON. Faber. 42s.

It is a refreshing change to read a book on poultry-keeping that opens with emphasis on the financial aspects of the business and maintains the same angle throughout the text. The chapter on breeding departs from the usual preoccupation with the importance of breed and stresses the value of breeding, without making it appear a mystic rite to which only a few may be admitted.

The book should be regarded as a kind of encyclopaedia, as implied by its title. It deals with the many aspects of poultry-keeping in a concise but comprehensive fashion. Students will find the chapter on housing construction of particular interest, for this is an important subject which is rarely covered in detail by the generality of omnibus poultry books. It is perhaps a pity that the chapter on Management for Egg Production does not follow on Chapters VIII and IX dealing with housing, an arrangement which would have achieved a better sense of continuity. Some parts of these two chapters could with advantage have been included in the sections on management ; the present layout leaves the reader with a feeling that more could be said about the advantages and limitations of the several systems of management.

The chapter on Nutrition treats this complicated, but all-important subject, in a useful manner, but it would have made for easier reading if many of the tables had been relegated to an appendix—where they would have been more readily accessible—while the series of formulae for rations might more properly have appeared in the succeeding chapter which deals with Feeding for Egg Production. And is there not a tendency to under-estimate the importance of the main constituents of a ration—does vitamin E really deserve half as much space as that devoted to the carbohydrates ?

For those who wish to learn something of the importance of the poultry industry, the Introduction presents to the reader a number of salient facts realized all too infrequently. For the intending poultry-keeper the same section gives an excellent appreciation of the prospects—and of the needs in terms of capital and labour, with some idea of the risks attendant on the venture and the rewards that may be gained. This introduction might with advantage be read by all intending poultry-keepers.

The book is excellently illustrated—especially the many drawings giving the detail of construction and design. With some further attention to the sections on feeding and management, the volume will become a first-rate book of reference ; in its present form it is a valuable addition to poultry writings.

R.C.

British Plants and their Uses. H. L. EDLIN. Batsford. 15s.

In this well-written, informative account of the economic uses of British plants, the author cuts right across the boundaries separating the wild from the cultivated to review the entire range of British plants. The book incorporates a wealth of interesting folk-lore and mentions many age-old recipes and customs of the country, but these are skilfully blended with more modern facts from the author's own experience relating to current practice in the numerous trades and crafts which are linked with plants in one way or another. The only important groups excluded are the timber trees, edible fungi, and ornamental garden plants !

An idea of the scope of this work may be obtained from the headings of some of the chapters—grasslands and mountain pastures ; straw, rush, reed, sedge and marram ; blanched greens and cresses ; fruits and nuts ; condiments, hops and tobacco ; dyestuffs ; peat mosses, and the harvest of the sea-shore. The author has succeeded in covering this wide field without sacrifice of style, for this book is no mere collection of notes ; indeed, it is eminently readable. Naturally, one cannot expect detailed information in a book of this size, but there will be few who will not find something new and interesting in it. Regrettably, however, the author gives no references, either to his own sources of information or to other works on the subject.

The book is well illustrated with photographs and engravings ; the older figures are of particular interest in that they show a stage in the progress of the art of botanical illustration, but they cannot seriously be regarded as satisfactory aids to identification, and one feels that some might have been omitted in favour of more practical illustrations.

I should like to add a word of warning ; the edible red pulp of the fruit of the yew (*Taxus baccata*) is referred to ; but the author omits to mention that the seed within is poisonous.

S.G.H.

BOOK REVIEWS

Oxford Junior Encyclopaedia. Vol. VI. Farming and Fisheries. Oxford University Press. 30s.

Six volumes of the total of twelve comprising this new encyclopaedic work have now been published. This latest, covering farming, forestry and fishing in all parts of the world is well up to standard. Its many black and white illustrations and eight coloured plates will create interest and in many cases do away with the need for lengthy written explanation.

The articles are arranged so as to encourage young people to pursue a subject by cross reference in this or other volumes of the series. When one remembers Patrick Wright's twelve volumes of the old Standard Cyclopedia of Agriculture, it is obvious that this part volume cannot cover the subject of farming, especially in the light of developments during the past decade. Modifications of practice have been varied and cumulative so that definite information on farming today is apt to be out of date before the print of a reference book is dry. This is avoided to some extent in the volume under review ; here the information is in general terms and the aim is to stimulate interest rather than provide answers to all possible questions.

It may be over-critical to object to some of the headings. If one looks up "Shows" one is referred to " Agricultural Shows " or if " Education " see " Agricultural Training " ; one might ask " Why *Agricultural* anything in a book dealing mainly with farming ?" Again, it is faintly irritating for there to be a heading "Hedges" which refers one to "Hedging" on the previous page or "Arboretum" see "Arboriculture" on the following line.

Fortunately, the young people who are lucky enough to receive this handsome book for their birthdays or at Christmastime, or have opportunity to borrow it from their school or public libraries, will not view it in this carping spirit, but in the spirit in which it was written and given.

The printers are to be commended on the very reasonable price at which they have been able to produce it.

W.R.S.

The Practice of Arable Crop Experimentation. P. N. Harvey. Norfolk Agricultural Station. 6s.

A valuable summary of methods which have been developed in field experiments at the Norfolk Agricultural Station at Sprowston over a long period is provided in this 79-page, illustrated booklet. In the main it is a detailed description of the marking out of plots, and the sowing or planting and harvesting of experimental crops. The emphasis is on cereals and roots (including potatoes) grown in rows. The appropriate procedures for these crops are clearly set out and provide all that the experimenter requires. Many hints are given to help maintain good relations with the farmer whose land is used for experiments.

A comparison of Mr. Harvey's methods with those familiar to the reviewer reveals many differences of detail ; it is to be hoped, therefore, that the publication of this booklet will stimulate discussion of local variations in experimental methods. Such discussion should be of considerable value to all experimenters and might lead to more trials designed specifically to compare the merits of different experimental techniques.

The introductory chapters deal briefly with the general considerations of statistical design and control of error. The method of randomizing the allocation of treatments to plots needs slight modification, however, when the number of treatments is not a divisor of 100.

Certain crops are not dealt with in this summary, since they are not grown for experiments at Sprowston. Thus there is no mention of kale or of any crop sown broadcast, and the special difficulties of trials involving spraying treatments are not considered. Apart from a few passing references the author gives no account of the special considerations involved in long-term trials involving crop rotations. Despite these limitations, the booklet should be of great help to experimenters who may not yet have established a rigid technique. It will also serve a second very useful purpose if it encourages other field experimenters to record their methods and to cover some of the subjects omitted by Mr. Harvey.

G.V.D.

BOOK REVIEWS

East Malling Research Station. Annual Report, 1951. 12s. 6d.

In addition to an account of the year's work on the experimental farm, a general review of fruit research, and a number of research reports, this year's report includes three noteworthy bulletins for fruit growers dealing with frost protection of fruit blossom by the water-spraying method, the pruning of maiden apple trees, and the newer organic fungicides.

The 1951 Amos Memorial Lecture, which is intended to convey information on both scientific and practical aspects of fruit growing, is printed here in full. Given by Mr. T. Neame, it dealt with developments in fruit growing at home and abroad during the past thirty years, and it is interesting to read the views of this experienced and widely-travelled grower on problems both old and new.

Many of the thirty-six research papers in Part III of the report will interest practical growers as well as scientists. Among these may be mentioned the following :

Experiments to find whether the size of Cox's Orange apples is influenced by their pollen parent show that significant differences do occur. The time of pollination also appears to affect the size of the fruit in its early stages of growth, but this effect tends to diminish as the fruit matures.

A description of a new dessert apple which has been developed at E. Malling is given. Named Michaelmas Red, it is intended to follow Worcester Pearmain.

An account of raspberry varieties of commercial importance gives a concise tabular statement of characteristics, including texture, flavour and picking quality. New hybrids are described as well as older varieties.

In fruit-drop control studies, naphthalene-acetic acid sprays applied with lime sulphur and mercurated lead arsenate sprays in May and June, did not affect fruit drop of the Bramley's Seedling apple. Postponement of picking for periods up to one month led to considerable fruit drop, but it was largely compensated by increase in individual fruit weight. With Cox's Orange, naphthalene-acetic acid treatment about three weeks before normal picking time reduced fruit drop ; postponement of picking increased it.

The report also contains several descriptions of methods and techniques, developed in the course of fruit research, of plant analysis, and biochemical and statistical procedures, which will appeal to workers in other fields of research.

There is an interesting preliminary account of a species of moth—the Summer Fruit Tortricid—which attacks fruit, especially apples, and a separate report on the result of some experiments to control this and other pests by spraying. It seems likely that this species may be more widespread in this country than was at first supposed. Finally, there are a number of reports on virus and other diseases of fruit, work on insect pests, and trials of new selections of Golding hops.

A.J.L.L.

A World Dictionary of Breeds, Types and Varieties of Livestock. I. L. Mason. Commonwealth Agricultural Bureaux. 30s.

For many years it has been accepted that consistency in the terminology used in *Animal Breeding Abstracts* is necessary if the material is to have its full value. With this in mind, the World Dictionary of Breeds—the first of its kind—has been compiled, after much inquiry and careful collection of data from all parts of the world, to " clarify many doubts and remove many inconsistencies regarding the nomenclature of breeds, types and varieties of farm livestock." It should be most useful to reference libraries and especially agricultural colleges.

The book is divided into two sections. The first part, containing over 4,000 entries, gives the various names for each of the species : horse, cattle, sheep, pig, goat, ass and buffalo. An English name is recommended for each species, with mention of English synonyms and foreign names, and such important details as place of breeding, breed characters, origin, relationship to other breeds, and etymology of the name.

Part II gives information about breed composition alphabetically under *countries* instead of breed names as in the first section. This part also includes livestock statistics, and an appendix referring to literature on the livestock of each country.

It is noteworthy that although the Dictionary is as yet not illustrated, the Bureau is making a collection of photographs and hopes to issue a supplementary volume of plates at a future date.

D.Z.M.

Modern Trends in the Breeding of Poultry for Egg Production. F. J. DUDLEY. Shell-Mex and B.P. Farm Service.

This addition to the Shell-Mex and B.P. Farm Service series of poultry booklets is almost 60 pages long and well worth reading, if only for the fact that it describes in simple language the elements of modern scientific technique as applied to breeding for increased egg-production.

The first half of the booklet discusses the sampling nature of inheritance, variation and its causes, the significance of heritability, and the measurement of egg-production. The remainder deals with systems of mating in general and some modern systems in particular, ending with an outline of the Ministry of Agriculture and Fisheries Poultry Stock Improvement Plan.

In his concluding remarks, the author emphasizes the fact that it is impossible to prescribe a "best" policy for breeding poultry as a number of important problems have yet to be solved.

The publication is available free from any of the Company's divisional offices or direct from : Shell-Mex and B.P. Ltd., Shell Mex House, Strand, London, W.C.2

G.E.M.

Recommended Common Names for Pest Control Products. British Standard 1831 : Pt. 1, 1952. British Standards Institution. 2s. 6d.

There has been a long-felt want for simple, easily pronouncable names for organic chemicals used in agriculture. This want resulted in a Technical Committee of the B.S.I. being set up to prepare a British Standard list of common names for established pest control products.

The suggested names do not conflict with proprietary names, but are intended for everyday use to assist users in the identification of the active ingredients of pest control products having otherwise cumbersome technical names.

In their selection of common names the Committee are to be congratulated that they have not unnecessarily changed such generally accepted names as DDT, BHC, 2,4-D, or MCPA, although they propose, in the future, to avoid the use of letters and research numbers. As regards numbers, all will agree with their findings, but the avoidance of the use of letters, which are the key letters in a chemical formula, is perhaps open to question. Firstly, because it is a convenient method of remembering formulae and relating them to their structure. Secondly, it is an accepted practice in chemical laboratories to name compounds in daily use in this way and they are, therefore, likely to have been christened, at least in select circles, before the Committee can get to work.

The common names adopted for various salts of dithiocarbamates, ferbam, nabam, zineb and ziram have a pleasing Old Testament flavour about them, while it has been wisely insisted that the recommended common name shall be spelt with a small initial letter. This does not, of course, apply where initials, such as DNC, are used.

It is certain that this booklet is indispensable to anyone concerned with agricultural chemicals.

R. de B.A.

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